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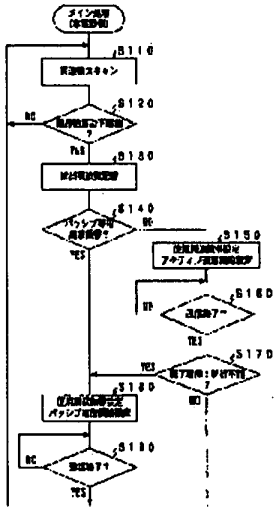
(54) COMMUNICATION SYSTEM BETWEEN ROAD AND VEHICLES, ON- VEHICLE DEVICE AND ON-ROAD APPARATUS



(57)Abstract:

PROBLEM TO BE SOLVED: To provide an on-vehicle device which can deal with any of two systems (an active system and a passive system) used in a communication between road and vehicles, to provide an on-road apparatus and to provide a communication system between road and vehicles.

SOLUTION: The on-vehicle device scans the downlink of the active system, and it scans a frequency band used in the passive system. When the electric-field strength of received radio waves is a preset lower-limit value or more, the on-vehicle device is regarded as having marched into the communication area of the on-vehicle apparatus, and its frequency is stored (S110 to S130). When the stored frequency belongs to a frequency band exclusively used in the passive system, a passive communication part is immediately started, and a communication by the passive system is started. When the stored frequency belongs to a frequency band used in common by both systems, the active communication part is first started, and a communication by the active system is tried. When the content of a received signal cannot be analyzed, the passive communication part is started so as to be changed over to the communication by the passive system (S140 to S190).

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CLAIMS

[Claim(s)]

[Claim 1] It is the mounted vessel for a communication link between highway and vehicle carried in a car for the communication link with the machine on the street installed near the transit path of a car. The 1st car side means of communications which performs the communication link with a machine on the street with the active method which goes up using a received frequency band which gets down and is different from a signal, and transmits a signal autonomously, The 2nd car side means of communications which performs the communication link with a machine on the street with the passive method which answers by modulating and returning the subcarrier which receives following this question signal non-become irregular with a reply signal to the received question signal, The mounted vessel which either of said 1st or 2nd car side means of communications will be operated, and will be characterized by having the car side change control means which will be changed to another side if a communication link is impossible if it advances into the communications area of said machine on the street.

[Claim 2] It is the mounted vessel according to claim 1 which establishes a frequency discrimination means to identify the frequency band of the signal received from said machine on the street, and is characterized by said car side change control means operating immediately the car side means of communications corresponding to this communication mode when the frequency band identified with said frequency discernment means is a frequency band of dedication in the communication mode of either said active method or a passive method.

[Claim 3] It is the mounted vessel for a communication link between highway and vehicle carried in a car in order to perform the communication link with the machine on the street installed near the transit path of a car. The 1st car side means of communications which performs the communication link with a machine on the street with the active method which goes up using a received frequency band which gets down and is different from a signal, and transmits a signal autonomously, The 2nd car side means of communications which performs the communication link with a machine on the street with the passive method which answers by modulating and returning the subcarrier which receives following this question signal non-become irregular with a reply signal to the received question signal, The mounted vessel which will be made to carry out juxtaposition actuation of said 1st and 2nd car side means of communications, and will be characterized by having a selection-control means to operate continuously the side from which the normal output was obtained if it advances into the communications area of said machine on the street.

[Claim 4] The mounted vessel of the active method which goes up using a received frequency band which gets down and is different from a signal, and transmits a signal autonomously, And it is the machine on the street for a communication link between highway and vehicle which can communicate with all of the mounted vessel of the passive method which answers by modulating and returning the subcarrier which receives following this question signal non-become irregular with a reply signal to the received question signal. The 1st road-side means of communications which performs the communication link with the mounted vessel of said active method, and the 2nd road-side means of communications which performs the communication link with the mounted vessel of said passive method, The machine on the street characterized by setting up a preparation and said 1st and 2nd road-side means of communications so that it may be arranged without each communications areas overlapping mutually in accordance with the transit path of a car.

[Claim 5] The mounted vessel of the active method which goes up using a received frequency band which gets down and is different from a signal, and transmits a signal autonomously, And it is the machine on the street for a communication link between highway and vehicle which can communicate with all of the mounted vessel of the passive method which answers by modulating and returning the subcarrier which

receives following this question signal non-become irregular with a reply signal to the received question signal. The 1st road-side means of communications which performs the communication link with the mounted vessel of said active method, and the 2nd road-side means of communications which is set up so that this 1st road-side means of communications and a communications area may be in agreement, and performs the communication link with the mounted vessel of said passive method, The machine on the street characterized by setting up a preparation and said 1st and 2nd road-side means of communications so that the frequency bands used for each communication link may differ mutually.

[Claim 6] The mounted vessel of the active method which goes up using a received frequency band which gets down and is different from a signal, and transmits a signal autonomously, And it is the machine on the street for a communication link between highway and vehicle which can communicate with all of the mounted vessel of the passive method which answers by modulating and returning the subcarrier which receives following this question signal non-become irregular with a reply signal to the received question signal. The 1st road-side means of communications which performs the communication link with the mounted vessel of said active method, and the 2nd road-side means of communications which is set up so that this 1st road-side means of communications and a communications area may be in agreement, and performs the communication link with the mounted vessel of said passive method, The machine on the street characterized by having the road-side change control means which operates alternatively either of said 1st or 2nd road-side means of communications according to the timing set up beforehand.

[Claim 7] It is the machine on the street characterized by setting up at least one slot for data to which use use the communication link frame which established two or more slots for data as for said 1st road-side means of communications in the machine [according to claim 6] on the street so that a broadcast with two or more mounted vessels might be possible, and according [said road-side change control means] to said 1st road-side means of communications was forbidden, and operating said 2nd road-side means of communications at the period of this slot for data.

[Claim 8] Said road-side change control means is a machine [according to claim 7] on the street characterized by operating said 2nd road-side means of communications also in this slot period when an opening is in said slot for data.

[Claim 9] The active method with which a mounted vessel transmits autonomously the going-up signal to a machine on the street using a frequency band which was received from the machine on the street, and which gets down and is different from a signal, It is the communication system between road and car with which the passive method which answers by a mounted vessel modulating the subcarrier which is not modulated [which is transmitted following this question signal] with a reply signal to the question signal received from the machine on the street, and returning is intermingled. The slot for uphill control for a mounted vessel to write in the communication link demand to a machine on the street as a communication link frame for a communication link between highway and vehicle, Two or more slots for data assigned to the mounted vessel with which the communication link was permitted, It is sent out ahead of this slot for data, and said slot for uphill control. The thing for the active methods which get down and consist of a slot for control for a machine on the street to notify the allocation condition of said slot for data to a mounted vessel is used. A machine on the street The subcarrier non-become irregular is transmitted to the period of said slot for uphill control, and the period within the slot for data assigned to the mounted vessel of a passive method which gets down and follows a signal. While processing the reply signal returned from the mounted vessel of a passive method in modulating this subcarrier as a thing equivalent to the going-up signal from the mounted vessel of an active method While the mounted vessel of a passive method modulates and returns the subcarrier which is not modulated [which gets down, considers that the slot for control is a polling signal, and is transmitted to the period of said slot for uphill control] with said reply signal over a polling signal When allocation of a slot with as opposed to [get down and / for / said / data] the mounted vessel concerned to the slot for control is shown, the communication system between road and car which gets down, makes a signal a querying signal and is characterized by modulating and returning the subcarrier which is not modulated [which is transmitted following on this going-down signal] with the reply signal over a querying signal received at the period of this slot for quota **** data.

[Claim 10] It is the machine on the street used with a communication system between road and car according to claim 9. The road-side means of communications which performs the communication link with a mounted vessel by the active method using said communication link frame which gets down and consists of the slot for control, a slot for data, and a slot for uphill control, A subcarrier transmitting means to transmit the subcarrier non-become irregular to the period of said slot for uphill control, and the period within the slot for data assigned to the mounted vessel of a passive method which gets down and follows a signal, A preparation and said road-side means of communications are a machine on the street characterized by processing the reply signal returned from the mounted vessel of a passive method in modulating said

subcarrier as a thing equivalent to the going-up signal from the mounted vessel of an active method.

[Claim 11] If it is the mounted vessel of the passive method used with a communication system between road and car according to claim 9 and advances into the communications area of a machine on the street A 1st response means to modulate and return the subcarrier which is not modulated [which gets down, considers that the slot for control is a polling signal, and is transmitted to the period of said slot for uphill control] with said reply signal over a polling signal, When allocation of a slot with as opposed to [get down and / for / said / data] the mounted vessel concerned at the slot for control is shown, the mounted vessel which gets down, makes a signal a querying signal and is characterized by having a 2nd response means to modulate and return the subcarrier which is not modulated [which is transmitted following on this going-down signal] with the reply signal over a querying signal received at the period of this slot for quota **** data.

[Claim 12] In the mounted vessel equipped with a frequency discrimination means to identify the frequency band of the signal which it was carried in the car for the communication link with the machine on the street installed near the transit path of a car, and was received from said machine on the street for a communication link between highway and vehicle A field strength measurement means to measure the field strength of the frequency band with which said frequency discrimination means was set up, It has the frequency change means which changes the frequency band used as the measuring object in this field strength measurement means one by one according to the change pattern set up beforehand. Said change pattern The mounted vessel characterized by being set up so that the frequency of occurrence of the frequency band assigned to the specific applications which must complete processing in the limited time amount may become high.

[Claim 13] It is the mounted vessel according to claim 12 which establishes a rate acquisition means to acquire the travel speed of a car, and is characterized by changing this unit unit hour so that said unit unit hour may become short, so that the travel speed acquired with said rate acquisition means is early, while said frequency change means changes the frequency band which serves as the measuring object for every set-up unit unit hour.

[Claim 14] A storage means to memorize the machine information on the street which includes at least the information about the reference-by-location speciality stage which acquires the current position of a car, and the frequency band which the machine on the street which was classified beforehand, and which was installed in each area for every area uses, Based on the machine information on the street memorized by this storage means, the frequency band used as the candidate for retrieval in said frequency discrimination means is narrowed down from the current position acquired in said reference-by-location speciality stage. The mounted vessel according to claim 12 or 13 characterized by establishing a change pattern setting means to set up said change pattern.

[Claim 15] claim 12 characterized by said specific application being processing about an electronic toll collection system (ETC) thru/or claim 14 -- either -- the mounted vessel of a publication.

[Claim 16] claim 12 characterized by said specific application being processing about an electronic number plate thru/or claim 14 -- either — the mounted vessel of a publication.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention relates to the communication system between road and car with which two methods (passivity — active) currently used for the communication link between highway and vehicle are intermingled and the mounted vessel which can respond to the various applications through both methods or a communication link between highway and vehicle, and a machine on the street.

[0002]

[Description of the Prior Art] It is DSRC (Dedicated Short Range Communication) as a communication mode for realizing tariff automatic **** (ETC) in a turnpike etc. by

conventionally performing two-way communication between the mounted vessel carried in the car, and the machine on the street installed near the transit way of a car. It is known. In this communication mode, the passive method (it adopts in Europe, China, and Southeast Asia) which performs transmission of the going-up signal of two methods, i.e., the machine on the street from a mounted vessel, by modulating and returning the subcarrier from a machine on the street to a mounted vessel which gets down and is transmitted after a signal, and the active method (it adopts in Japan) with which a mounted vessel performs transmission of an uphill signal autonomously using a frequency band which gets down and is different from a signal exist.

[0003] For this reason, even if the road continues, the communication mode currently used for ETC on the boundaries (border etc.) which change political jurisdiction and law can change to an active method (or that reverse) from a passive method, or it is possible that the machine of a formula on the street is intermingled and is both arranged in the area which faced across the above-mentioned boundary in the future.

[0004]

[Problem(s) to be Solved by the Invention] And since a communication link was impossible with the machine on the street from which it will not only be spoiled, but [when the convenience that tariff **** can be performed without suspending a car by the car only carrying the mounted vessel corresponding to one of methods crosses the above-mentioned boundary,] a communication mode differs in the case of the former, there was a problem that it may be dealt with as a violation car by such machine on the street.

[0005] Moreover, since some frequency bands to be used overlapped mutually by the active method and the passive method in the case of the latter, interference arose, communication link quality deteriorated and there was a problem that there was a possibility that communicating may become impossible. As a slash shows to drawing 21 , namely, to an active method The frequency bands Fad1, Fad2, Fau1, and Fau2 which are four whose bandwidth which makes center frequency 5795MHz, 5805MHz, 5835MHz, and 5845MHz is 5MHz To the object for the going-down signals from a machine on the street to a mounted vessel (Fad1, Fad2), and the going-up signals (Fau1, Fau2) from a mounted vessel to a machine on the street Two are assigned at a time, respectively. On the other hand, to a passive method 5797. The frequency bands Fp1-Fp4 which are four whose bandwidth which makes center frequency 5 MHz, 5802.5 MHz, 5807.5 MHz, and 5812.5 MHz is 5MHz are assigned to the bidirectional communication link by each. Therefore, in Fad1 of an active method, Fp1 of a passive method and Fad2 of an active method may cause Fp2, Fp3, and interference of a passive method.

[0006] By the way, by recent years, it considers offering the new application which used the DSRC communication link in the communication link frequency band of a 5.8GHz band using the frequency band which is not used for ETC. In this case, a frequency band which is different from the active method of the existing ETC as shown in drawing 21 , The frequency bands Fed1-Fed5 which are ten pieces whose bandwidth which makes center frequency 5775MHz, 5780MHz, 5785MHz, 5790MHz, 5800MHz, 5815MHz, 5820MHz, 5825MHz, 5830MHz, and 5840MHz, respectively is 5MHz The thing from (on-the-street machine to a mounted vessel for which it gets down and) for signals, and Feu1-Feu5 (for the going-up signals from a mounted vessel to a machine on the street) are used is planned.

[0007] Therefore, to constitute so that a mounted vessel can respond not only to the existing ETC but to these new applications will be demanded from now on. That is, the function which chooses the application which performs a mounted vessel based on the frequency band of not only the function to identify an active method and a passive method but the received electric wave is needed.

[0008] while the communication link had gone wrong by designing a system so that a communicative retry might become possible when a communication link went wrong in order to secure the dependability of a system by ETC especially, the probability for a car to pass through a communications area becomes small enough (it is one or less set to 1 million sets) -- it is made like.

[0009] The time amount to which a car passes through a communications area at a setting car rate (assumption full speed) was specifically set as about 3 times of the time amount taken [after the frequency band used is specified] to complete ETC processings (authentication, store to a card, etc.), and sufficient float is secured.

[0010] However, with the mounted vessel which can respond to all of ETC application and new application, as compared with what performs only ETC application, it will have to look also for five frequency bands too much, and specification of the frequency band used took time amount, consequently the float for communication link retries will be deleted, and there was a problem of reducing communicative dependability.

[0011] the mounted vessel which can cope with all of two methods (activeness — passive) used by communication link between highway and vehicle in order that this invention may solve the above-mentioned trouble, and a machine on the street — And set it as the 1st purpose to offer a communication system between road and car, and further, without reducing the dependability of specific applications, such as ETC which must complete processing within the limited time amount It sets it as the 2nd

purpose to offer the mounted vessel which can cope with various applications.

[0012]

[Means for Solving the Problem] With the mounted vessel according to claim 1 which is invention for attaining the above-mentioned purpose The active method which the 1st car side means of communications goes up using a received frequency band which gets down and is different from a signal, and transmits a signal autonomously performs the communication link with a machine on the street. The passive method which answers by modulating and returning the subcarrier which is not modulated [which the 2nd car side means of communications receives to the received question signal following this question signal] with a reply signal performs the communication link with a machine on the street.

[0013] And if it advances into the communications area of a machine on the street, a car side change control means will search the car side means of communications which can communicate by operating either of the 1st or 2nd car side means of communications, and changing to another side, if a communication link is impossible. Therefore, according to the mounted vessel of this invention, even if a machine on the street is the model of dedication corresponding to either an active method or a passive method, it can communicate with this certainly.

[0014] in addition, when the frequency band of dedication with which the common use with another side does not become exists by the active method and the passive method in the frequency band to be used The frequency band of the signal transmitted from a machine on the street with a frequency discrimination means like according to claim 2 is identified. A car side change control means As long as the identified frequency band is a frequency band of dedication in one of communication modes, you may make it operate immediately the car side means of communications corresponding to the communication mode.

[0015] In this case, since the search for specifying any can communicate among the 1st and 2nd car side means of communications will be performed only when the frequency band identified with the frequency discrimination means is what both communication modes share, the mean time to communication link initiation can be shortened.

[0016] Next, with a mounted vessel according to claim 3, if it advances into the communications area of a machine on the street, a car side selection-control means carries out juxtaposition actuation of the 1st and 2nd car side means of communications, and the side from which the normal output was obtained will be operated continuously. Therefore, even if a machine on the street is the model of dedication corresponding to either an active method and a passive method, it can communicate with this certainly and, moreover, the communication link with a machine on the street can be made to start by necessary minimum time amount according to the mounted vessel of this invention.

[0017] Although the mounted vessel constituted so far so that any communication mode could be coped with was explained, the machine on the street constituted from below so that any communication mode could be coped with is explained. First, in the machine [according to claim 4] on the street, it had the 1st road-side means of communications which performs the communication link with the mounted vessel of an active method, and the 2nd road-side means of communications which performs the communication link with the mounted vessel of a passive method, and these 1st and 2nd road-side means of communications is set up so that it may be arranged without each communications areas overlapping mutually in accordance with the transit path of a car. Therefore, the car which runs in accordance with a transit path will pass through each of each communications areas of the 1st and 2nd road-side means of communications.

[0018] Thus, since the communications area of both communication modes was separated spatially, though the same frequency band was used by both communication modes according to the machine of this invention on the street, the signal of both communication modes does not cause interference and good communication link quality is secured also to the mounted vessel of which communication mode. Consequently, even if the mounted vessel carried in the car is the thing of dedication in one of communication modes, it can communicate with this certainly.

[0019] Next, in the machine [according to claim 5] on the street, each communications area was in agreement, and moreover, the 1st and 2nd road-side means of communications is set up so that the frequency bands used for each communication link may differ mutually. Thus, according to the machine of this invention on the street, since the signal of both communication modes is separated in frequency, even if the communications area of both communication modes is the same, the signal of both communication modes does not cause interference and good communication link quality is secured also to the mounted vessel of which communication mode. Consequently, even if the mounted vessel carried in the car is the thing of dedication in one of communication modes, it can communicate with this certainly.

[0020] Moreover, next, with the machine [according to claim 6] on the street, the 1st

and 2nd road-side means of communications is set up so that each communications area may be in agreement, and the road-side change control means is operating alternatively either of the 1st or 2nd road-side means of communications according to the timing set up beforehand.

[0021] Thus, according to the machine of this invention on the street, since the signal of both communication modes is separated in time, even if the communications area of both communication modes is the same, the signal of both communication modes does not cause interference, and even if it is the mounted vessel of which communication mode, good communication link quality is secured. Consequently, even if the mounted vessel carried in the car is the thing of dedication in one of communication modes, it can communicate with this certainly.

[0022] in addition, as timing to which a road-side change control means changes the road-side means of communications (namely, communication mode) to operate Although you may make it change in the unit of the communication link frame which each uses, for example, like claim 7 publication When what established two or more slots for data is used so that a broadcast with two or more mounted vessels may be possible as a communication link frame of an active method At least one slot for data to which use by the 1st road-side means of communications was forbidden is set up, and you may make it operate the 2nd road-side means of communications at the period of the slot for data.

[0023] Furthermore, a road-side change control means has few mounted vessels of the active method which needs the communication link with a machine on the street like according to claim 8 than the number of the slots for data secured to active methods, and when an opening is in the slot for data, you may make it operate the 2nd road-side means of communications also in this slot period.

[0024] In this case, the slot for data can be used efficiently, a communication link with the passive method which can communicate only with one mounted vessel at a time can be terminated in a short time, and a throughput can be raised. By the way, it is expected that equipment is enlarged although either has the means of communications of activeness and passive both methods, it is not necessary to add modification to the procedure of each communication mode since it is used changing this, and it can constitute from an above-mentioned approach easily conventionally using equipment.

[0025] In order to solve this problem, in a communication system between road and car according to claim 9 The slot for uphill control for a mounted vessel to write in the communication link demand to a machine on the street as a communication link frame for the communication link between vehicles, as shown in drawing 22 (it corresponds to ACTS), Two or more slots for data assigned to the mounted vessel which permits a communication link based on the communication link demand written in this slot for uphill control (it corresponds to MDS), It is sent out ahead of the slot for data, and the slot for uphill control, and the thing for the active methods which get down and consist of a slot for control (it corresponds to FCM) for a machine on the street to notify the allocation condition of the slot for data to a mounted vessel is used. A machine on the street and the mounted vessel of a passive method are constituted as follows so that a communication link with a passive method may also become possible using this communication link frame.

[0026] That is, a machine on the street transmits the subcarrier non-become irregular to the period of the slot for uphill control, and the period within the slot for data assigned to the mounted vessel of a passive method which gets down and follows a signal, and processes the reply signal returned from the mounted vessel of a passive method in modulating this subcarrier as a thing equivalent to the going-up signal from the mounted vessel of an active method.

[0027] While modulating and returning the subcarrier which is not modulated [which the mounted vessel of a passive method gets down, on the other hand, considers that the slot for control is a polling signal, and is transmitted to the period of the slot for uphill control] with the reply signal over a polling signal When it gets down and allocation of the slot for data over the mounted vessel concerned is shown in the slot for control, it gets down, and a signal is made into a querying signal, and the subcarrier which is not modulated [which is transmitted following on this going-down signal] is modulated and returned with the reply signal over a querying signal received at the period of this slot for quota **** data.

[0028] Thus, since it is possible to carry out the partial change of the processing of a passive method, to enable it to be processed using processing of an active method and a common communication link frame, and to process the communication link with the mounted vessel of both communication modes in common according to the communication system between road and car of this invention, the configuration of the machine on the street which can cope with the mounted vessel of both communication modes can be simplified sharply.

[0029] Moreover, the communication procedure using going up of an active method / commands which it gets down and are used for a signal, and querying/reply signal of a passive method, and these commands is communalized, and processing to these signals can be performed, without being conscious of an active and passive difference.

[0030] In a communication system between road and car according to claim 9 in addition, a road-side machine for example, the communication link frame according to claim 10 which gets down and consists of the slot for control, a slot for data, and a slot for uphill control like -- using -- an active method -- the communication link with a mounted vessel -- carrying out -- obtaining -- road-side means of communications -- in addition A subcarrier transmitting means to transmit the subcarrier non-become irregular to the period of the slot for uphill control and the period within the slot for data assigned to the mounted vessel of a passive method which gets down and follows a signal is established. Road-side means of communications should just constitute the reply signal returned from the mounted vessel of a passive method in modulating a subcarrier so that it may process as a thing equivalent to the going-up signal from the mounted vessel of an active method.

[0031] Similarly, in a communication system between road and car according to claim 9, although the conventional thing can be used for the mounted vessel of an active method as it is Like for example, claim 11 publication, if the mounted vessel of a passive method advances into the communications area of a machine on the street The 1st response means gets down and considers that the slot for control is a polling signal. The subcarrier which is not modulated [which is transmitted to the period of the slot for uphill control] is modulated and returned with the reply signal over a polling signal. When the 2nd response means gets down and allocation of the slot for data over the mounted vessel concerned is shown by the slot for control, What is necessary is to get down, and to make a signal into a querying signal, and just to constitute so that the subcarrier which is not modulated [the / which gets down and is transmitted following on a signal] may be modulated and returned with the reply signal over a querying signal received at the period of the assigned slot for data.

[0032] Next, with a mounted vessel according to claim 12, it is carried in a car for the communication link with the machine on the street installed near the transit path of a car. With a frequency discrimination means to identify the frequency band of the signal received from said machine on the street, a field strength measurement means measures the field strength of the set-up frequency band, and a frequency change means changes the frequency band which serves as the measuring object with this field strength measurement means one by one according to the change pattern set up beforehand.

[0033] However, the change pattern is set up so that the frequency of occurrence of the frequency band assigned to the specific applications which must complete processing in the limited time amount may become high. Thus, since according to the mounted vessel of this invention the detector meeting of the frequency band for specific applications is made [many] and this frequency band is investigated preferentially, when specific application is offered from the machine on the street, it becomes possible to detect this promptly and to start processing promptly. Consequently, various applications can also be coped with, without fully being able to secure the float for communication link retries, and reducing the dependability of specific application.

[0034] In addition, you may constitute so that the travel speed acquired with a rate acquisition means is early, a unit unit hour may become short and this unit unit hour may be changed, while changing the frequency band which serves as the measuring object for every unit unit hour according to claim 13 to which the frequency change means was set like.

[0035] That is, the time amount taken for a car to pass through a communications area becomes short so that a travel speed is early, but if the time amount which specification of an operating frequency takes by adjusting a unit unit hour in this way is shortened, the time amount assigned to processing is securable. Moreover, machine information including the information about the frequency band which the machine on the street installed in each area according to claim 14 beforehand classified into the storage means like uses for a communication link between highway and vehicle on the street is made to memorize. Based on the machine information on the street memorized by this storage means, a change pattern setting means may narrow down the frequency band which serves as a candidate for retrieval with a frequency discrimination means from the current position acquired in the reference-by-location speciality stage, and it may constitute so that a change pattern may be set up.

[0036] In this case, since it can prevent certainly not measuring vainly the frequency band which the machine on the street is not using, and spending useless time amount on specification of an operating frequency and the processing time can also fully be secured, the dependability at the time of performing specific application can be raised further.

[0037] In addition, that what is necessary is just what processes to the car which passes through a communications area at a comparatively early rate, specific application may be processing according to claim 15 concerning ETC like, and may be processing according to claim 16 concerning an electronic number plate like.

[0038] Moreover, it cannot be overemphasized that invention according to claim 12 to 16 may be combined with invention according to claim 1 to 11.

[0039]

[Embodiment of the Invention] The operation gestalt of this invention is explained with a drawing below.

[1st operation gestalt] drawing 1 is a block diagram showing the configuration of the mounted vessel which can communicate with any machine on the street in the communication system between road and car of the 1st operation gestalt with which the machine on the street which offers ETC application by the communication link between highway and vehicle of an active method, and the machine on the street which offers ETC application by the communication link between highway and vehicle of a passive method are intermingled.

[0040] In addition, in the communication link between highway and vehicle of an active method, and the communication link between highway and vehicle of a passive method, the well-known communication link frame which each shows to drawing 22 shall be used. Namely, in the communication link between highway and vehicle of an active method, it has three message data slots (MDS) so that the broadcast of three sets of mounted vessels may be possible. A frame control message channel for a machine on the street to notify the allocation condition of MDS to a mounted vessel before the MDS (FCM), The communication link frame which consists of an activation slot (ACTS) for a mounted vessel to tell existence to a machine on the street after MDS is used (refer to drawing 22 (a)). In addition, FCM, MDS, and ACTS are equivalent to the slot for going-down control in this invention, the slot for data, and the slot for uphill control, respectively.

[0041] Moreover, in the communication link between highway and vehicle of a passive method, after transmitting a polling signal for a machine on the street to make desired data transmit to a mounted vessel, and a querying signal, only the period set up beforehand succeedingly transmits the subcarrier non-become irregular, and the method of modulating and returning this subcarrier with the reply signal corresponding to a polling signal or a querying signal is used (refer to drawing 22 (b)).

[0042] However, as the column of the conventional technique explained (refer to drawing 21), it sets to an active method. By the down link for the going-down signals from a machine on the street to a mounted vessel, two frequency bands Fau1 and Fau2 are used, respectively by the up link for the going-up signals from two frequency bands Fad1 and Fad2 and a mounted vessel to a machine on the street. A bidirectional communication link is made to be performed using Fad2 or Fau2 [the frequency bands Fad1 and Fau1 (it is Fa1 when naming two generically) of a pair, or] (similarly Fa2). Moreover, by the passive method, four frequency bands Fp1-Fp4 are used, and a bidirectional communication link is made to be performed using any one frequency band.

[0043] Below, the frequency band Fp4 without a lap with other frequency bands is called the frequency band only for passive, and frequency bands Fad1-Fad2 (that is, Fp1-Fp3 are contained) are called a common frequency band. As shown in drawing 1 , the mounted vessel 10 of this operation gestalt The field strength detecting element 12 which extracts the signal component of the specified specific frequency band from the input signal received with the antenna 11, and measures the receiving level (field strength), With the active communications department 13 as the 1st car side means of communications which performs the communication link with a machine on the street by the active method through an antenna 11 With the passive communications department 14 as the 2nd car side means of communications which performs the communication link with a machine on the street by the passive method through an antenna 11 It was constituted centering on the well-known microcomputer, each part 12-14 of the above was controlled, and it has the data-processing section 15 which performs processing of the data obtained by the communication link with a machine on the street etc. In addition, although not illustrated, the accounting equipment equipped with IC card reader writer etc. for tariff settlement of accounts is connected to the data-processing section 15.

[0044] It explains along with the flow chart which shows the Maine processing which the data-processing section 15 performs here to drawing 2 . If this processing starts, will output a measurement command to the field strength detecting element 12 first, from the lower cut off frequency of a frequency band Fad1 to the upper limited frequency of a frequency band Fp4 will be made to scan (S110), and it will supervise whether it is more than the lower limit to which the measured field strength was set beforehand (S120).

[0045] If field strength is smaller than a lower limit, it will return to S110 and measurement will be repeated, the frequency at that time is memorized as a detection frequency as that to which the car carrying the mounted vessel 10 concerned advanced into the communications area of a machine on the street when field strength was more than a lower limit (S130), and it judges whether the detection frequency belongs to the frequency band Fp4 only for passive (S140).

[0046] If the detection frequency does not belong to the frequency band Fp4 only for passive, the frequency band with which a detection frequency belongs It specifies out of the frequency bands Fad1 and Fad2 for down links of an active method. The active communications department 13 is set up so that it may communicate using the frequency band Faui for rise rings which becomes the specified frequency band Fadi

(i= 1 or 2) and this, and a pair, and (S150) and the communication link between highway and vehicle by the active method are made to start by starting this.

[0047] Then, after judging whether the communication link by the active communications department 13 was completed (S160) and completing a communication link, although the termination receives a signal, it judges whether it is what is depended on the analysis impossible which cannot analyze the contents (S170). And as it is, if communication link termination is not based on analysis impossible, if it is return and the thing to depend on analysis impossible on the other hand, to S110 The frequency band with which the detection frequency memorized in S130 of the point belongs is specified out of the frequency bands Fp1-Fp4 for passive methods. The passive communications department 14 is set up so that it may communicate using the specified frequency band, and (S180) and the communication link between highway and vehicle by the passive method are made to start by starting this.

[0048] Then, after judging whether the communication link by the passive communications department 14 was completed (S190) and completing a communication link, it returns to S110. On the other hand, when it is judged that the detection frequency belongs to the frequency band only for passive in S140, it shifts to S180, and hereafter, the passive communications department 14 is set up and started as explained previously, and the communication link between highway and vehicle by the passive method is made to start. However, a frequency band Fp4 will be used for a communication link in this case.

[0049] In addition, in this processing, S150-S190 are equivalent to the car side change control means in this invention, and S110, S120, and the field strength detecting element 12 are equivalent to a frequency discrimination means. That is, when the communication link between highway and vehicle by the active method is tried at first, an input signal cannot be analyzed, when the communication link between highway and vehicle by the passive method is immediately performed when the detection frequency from which field strength becomes more than a lower limit belongs to the frequency band only for passive in this processing, and it belongs to the other common frequency band, but a communication link goes wrong, it changes to a passive method and a communication link between highway and vehicle is made to be performed.

[0050] Here, it explains along with the flow chart which shows actuation of the active communications department 13 to drawing 3 . If the active communications department 13 starts like illustration, it would judge first whether a certain signal was received through the antenna 11 (S210) and the signal will be received, it will judge whether the signal is FCM (S220).

[0051] And if the contents are analyzed, it judges whether MDS is assigned to the self-car (S230) and it is not assigned when the received signal is FCM, it waits for the transmit timing of ACTS (S240), and after transmitting the response data for telling a machine on the street about existence of a self-car (mounted vessel 10) (S250), it returns to S210. The identification number (henceforth "Car ID") for specifying the car which carried the mounted vessel 10 concerned or the mounted vessel 10 concerned at least is contained in this response data.

[0052] a ****** [having stood by to the timing of the assigned MDS (S260), having got down to the timing, and having received the signal on the other hand, when MDS was assigned to the self-car (S230-YES), as a result of analyzing the contents of FCM] -- moreover, it judges whether the MDS [which received] command which it gets down and is the contents of the signal is normal (S270).

[0053] And even if it gets down, and it cannot receive a signal or it receives, when abnormalities are in the MDS command, return and as opposed to [on the other hand get down, and / when the MDS command is / that a signal is received / normal] the MDS command response data are transmitted to S210 as it is (S280). If it judged whether a series of communication links according to the procedure set up beforehand were completed (S300) and the communication link was completed by transmission of this response data If actuation of the active communications department 13 is suspended in it and the communication link is not yet completed in it after memorizing the communication link result which shows that the communication link was completed normally in the predetermined area of the memory which constitutes the data-processing section 15 (S310), it will return to it as it is S210.

[0054] When the signal received in S220 of the point is not FCM, according to a format of an active method, it judges whether it is the signal in which analysis is possible (S320), and if analysis is impossible, after outputting the notice of analysis impossible as a reason for termination of communication link termination (S330), actuation of the active communications department 13 will be suspended. In this case, since an affirmation judging is carried out in S180 of the Maine processing explained previously, a communication link between highway and vehicle with a passive method will be tried succeedingly.

[0055] Moreover, although the received signal is not FCM, when it is the signal in which analysis by format of an active method is possible (S320-NO), or when a signal cannot be received (S210-NO) If it judges whether it passed beyond the lock time

amount beforehand set as the last after starting the active communications department 13 after receiving FCM (S340) and has not gone through lock time amount yet It returns to S210 then, and on the other hand, if it has passed beyond lock time amount, actuation of the active communications department 13 will be suspended. In this case, it will return to a frequency scan (S110) immediately, without trying a communication link between highway and vehicle with a passive method, since a negative judging is carried out in S180 of the Maine processing.

[0056] Next, it explains along with the flow chart which shows actuation of the passive communications department 14 to drawing 4 . If the passive communications department 14 is started like illustration, it would judge first whether a certain signal was received through the antenna 11 (S410) and the signal will be received, it will judge whether they are normal things, such as a polling signal and a querying signal, (S420).

[0057] If the received signal is not normal, the subcarrier which will be transmitted to it after this on the other hand as it is if return and the received signal are normal to S410 will be modulated with the reply signal currently prepared beforehand, and it will return through an antenna 11 (S430). If actuation of the passive communications department 14 is suspended and the communication link is not yet completed after memorizing a communication link result in the predetermined area of memory (S450), if it judged whether a series of communication links according to the procedure set up beforehand were completed (S440) and the communication link was completed by transmission of this reply signal, it will return to S410 as it is.

[0058] if it judges whether it passed beyond the lock time amount set up beforehand (S460) and has not gone through lock time amount yet on the other hand, after receiving a polling signal or a querying signal at the last after starting the passive communications department 14 when a signal is unreceivable (S410-NO) -- as it is -- S410 -- return -- on the other hand, if it has passed beyond lock time amount, actuation of the passive communications department 14 will be suspended.

[0059] In addition, the reply signal / response data in S430, and S250 and S280 of the point are suitably set up by the application program using the communication link between highway and vehicle separately performed in the data-processing section 15. As explained above, when it has the active communications department 13 in which the communication link between highway and vehicle by the active method is possible, and the passive communications department 14 in which the communication link between highway and vehicle by the passive method is possible and advances into the communications area of a machine on the street in the mounted vessel 10 of this operation gestalt, search actuation which changes both the communications departments 13 and 14 one by one is performed, and the communication link between highway and vehicle with a machine on the street is made to be performed using the direction whose communication link is attained.

[0060] Therefore, according to the mounted vessel 10 of this operation gestalt, even if a machine on the street performs a communication link between highway and vehicle by any of an active method and a passive method, a communication link can be ensured with this. And with this operation gestalt, since the communication link between highway and vehicle by the passive method is made to start immediately when the frequency band which a machine on the street uses for a communication link between highway and vehicle is a frequency band only for passive, without performing search actuation, the mean time required by communication link initiation can be shortened.

[0061] In addition, when the detection frequency detected with a frequency scan belongs to the common frequency band with this operation gestalt, the active communications department 13 is started first. Although the communication link between highway and vehicle by the active method is tried, and it changes to the passive communications department 14 and he is trying to try the communication link between highway and vehicle by the passive method when it is not able to communicate Both the communications departments 13 and 14 are operated to coincidence, and it may be made to communicate by choosing the direction where a normal output is obtained.

[0062] In this case, as shown in drawing 5 , while the Maine processing omits S170 from the flow chart shown in drawing 2 , instead of S150 which starts only the active communications department 13, based on a detection frequency, the frequency band used of both the communications departments 13 and 14 sets it up, and it should just insert S155 which starts both the communications departments 13 and 14.

[0063] Moreover, if lock time amount passes after coincidence starting of both the communications departments 13 and 14 in this case, actuation will be suspended, but when lock time amount is comparatively long, at least one side is a time (S220-YES, S420-YES) of one of the communications departments receiving an effective signal first, and it may be constituted so that actuation of the communications department of another side may be stopped compulsorily. In this case, S155 and the processing which stops the side which cannot communicate are equivalent to the selection-control means in this invention.

[0064] Moreover, although especially processing of what is also omitted with this

operation gestalt when lock time amount passes in the active communications department 13 and the passive communications department 14 and actuation is ended, you may make it, operate the alarms (a lamp, buzzer, etc.) formed outside for example.
The [2nd operation gestalt] The 2nd operation gestalt is explained below.
[0065] Drawing 6 is a block diagram showing the configuration of the machine on the street formed for every lane of the tollgate of a turnpike in the communication system between road and car of the 2nd operation gestalt with which the mounted vessel which performs a communication link between highway and vehicle by the active method, and the mounted vessel which performs a communication link between highway and vehicle by the passive method are intermingled. In addition, in drawing 6 , (a) is the common machine on the street which can communicate with any mounted vessel of a communication mode, (b) is the mounted vessel of an active method, and the machine on the street [only for active] which can be communicated, and (c) is the mounted vessel of a passive method, and the machine on the street [only for passive] which can be communicated. Moreover, the communication link frame and the frequency band used for a communication link are the same as that of the case of the 1st operation gestalt.
[0066] With the active communications department 22 as the 1st road-side means of communications which performs the communication link between highway and vehicle with the mounted vessel of an active method through an antenna 21 first as common on-the-street machine 20a is shown in drawing 6 (a) With the passive communications department 24 as the 2nd road-side means of communications which performs the communication link between highway and vehicle with the mounted vessel of a passive method through an antenna 23 The timing control section 25 as a road-side change control means which controls the timing of both the communications departments 22 and 24 of operation, It was constituted centering on the well-known microcomputer, and has the data-processing section 26 in which both the communications departments 22 and 24 perform processing of the data sent and received by the communication link between highway and vehicle with a mounted vessel etc.
[0067] Next, it has the configuration to which on-the-street machine only for active 20b abbreviated an antenna 23 and the passive communications department 24 from common on the street machine 20a as shown in drawing 6 (b), and on-the-street machine only for passive 20c has the configuration which omitted an antenna 21 and the active communications department 22 from common on the street machine 20a, as shown in drawing 6 (c).
[0068] And although it consists of combining suitably and these machines 20 (20a-20c) on the street are not illustrated, the timing control section 25 of each machine 20 on the street consists of tollgates so that it may interlock mutually. Here, it explains along with the flow chart which shows the actuation of the active communications department 22 in the machines 20a and 20b on the street to drawing 7 . In addition, the active communications department 22 starts according to the command from the timing control section 25.
[0069] If the active communications department 22 starts like illustration, MDS processing transmits first FCM to which data were beforehand set by the data-processing section 26 (S510), and send for every MDS and receive data continuously between the mounted vessels to which the MDS was assigned will be performed (S520).
[0070] Then, if it judges whether the response data (car ID) from a mounted vessel were received (S530) and has not received to the timing of ACTS, this processing is ended as it is. On the other hand, if response data are received, Car ID and the number of responses which are the contents of the response data will be memorized in the predetermined area of the memory which constitutes the data-processing section 26 (S540), and this processing will be ended in it.
[0071] MDS allocation processing which assigns MDS in the data-processing section 26 based on the car data and the number of responses which were memorized in these S540 is performed, and while setting up the data transmitted in FCM of the following communication link frame (that is, used in S510), processing of setting up the condition of MDS assigned to the communication link with a mounted vessel "during slot use" is performed.
[0072] Next, it explains along with the flow chart which shows the detail of the MDS processing in S520 of the point to drawing 8 . Repeat (namely, this operation gestalt 3 times) activation of this processing shall be carried out for every timing of each MDS. If the condition of MDS set as the object of current processing will judge whether it is the no which is [slot] "under use" (S610) and "will not slot use [MDS processing is started like illustration, and] it" probably as a result of the MDS allocation processing by the data-processing section 26, this processing will be ended as it is. [be / it] On the other hand, if the condition of the MDS concerned "is slot using it", transmission (S620) of the MDS command currently beforehand prepared to the timing of the MDS and the response data from a mounted vessel will be received (S630), and it will judge whether the received response data are a normal thing corresponding to the transmitted MDS command (S640).
[0073] If response data are normal, it will judge whether a series of communication

links according to the sequence set up beforehand were completed (S650) and the communication link will not be completed by reception of the response data, degree sequence is prepared (setup of the MDS command which should be transmitted in S620 etc.) (S660), and this processing is ended. On the other hand, if the communication link is completed, the communication link result which shows that the communication link was completed normally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26 (S670), and this processing will be ended in it.

[0074] When it judged whether the counted value of the count of a retry would be larger than a upper limit if abnormalities are in response data in S640 of the point (S680), and it was below a upper limit and the processing concerned is started next time, a retry setup is carried out so that the same MDS command as what transmitted this time may be transmitted in S620 of the point (S690), and this processing is ended. On the other hand, if the counted value of the count of a retry is larger than a upper limit, the communication link result which shows what the communication link terminated abnormally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26 (S700), and this processing will be ended in it.

[0075] Thus, in the active communications department 22, by assigning MDS to the mounted vessel which answered to the timing of ACTS, and performing a different communication link for every MDS, a broadcast with a maximum of three mounted vessels is possible, and it is made. Next, it explains along with the flow chart which shows actuation of the passive communications department 24 to drawing 9 . In addition, the passive communications department 24 starts like the active communications department 22 according to the command from the timing control section 25.

[0076] If the passive communications department 24 starts like illustration, and it judges whether a setup "under passive communication link" has accomplished (S710) and is not [passive / be / it] "under communication link", [which shows first that it is communicating with the mounted vessel of a passive method] A polling signal is transmitted (S720), and succeedingly, only a predetermined period transmits a subcarrier and receives the response (what modulated the subcarrier with the reply signal showing Car ID) from a mounted vessel (S730).

[0077] At this time, it judges whether it is a normal thing corresponding to a polling signal (S740), and the contents of the received reply signal end this processing as it is, in not being normal. On the other hand, if the contents of the received reply signal are normal, the mount ID shown in the reply signal will be memorized in the predetermined area of the memory which constitutes the data-processing section 26, a setup "under passive communication link" will be performed in it (S750), degree sequence will be prepared for it (setup of the querying signal which should be transmitted in S770 mentioned later) (S760), and this processing will be ended in it.

[0078] If a setup "under passive communication link" is made in S710 of the point, the querying signal currently prepared beforehand is transmitted (S770), and succeedingly, only a predetermined period will transmit a subcarrier and will receive the response (what modulated the subcarrier with the reply signal) from a mounted vessel (S780).

[0079] Judge whether at this time, the contents of the received reply signal are the normal things corresponding to the querying signal transmitted in S770 (S790), and if normal If it judges whether a series of communication links according to the sequence set up beforehand were completed (S800) and the communication link is not completed by reception of the reply signal, the following sequence is prepared (S760) and this processing is ended. On the other hand, if the communication link is completed, the communication link result which shows that the communication link was completed normally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26, a setup "under passive communication link" will be canceled in it (S810), and this processing will be ended in it.

[0080] This processing is ended, after carrying out a retry setup (S830) so that the same querying signal as what transmitted this time may be transmitted in S770 of the point when it judged whether the counted value of the count of a retry would be larger than a upper limit if abnormalities are in the reply signal received in S790 of the point (S820), and it was below a upper limit and the processing concerned is started next time. On the other hand, if the counted value of the count of a retry is larger than a upper limit, the communication link result which shows what the communication link terminated abnormally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26, a setup "under passive communication link" will be canceled in it (S840), and this processing will be ended in it.

[0081] Thus, in the passive communications department 24, any one and the communication link in the mounted vessel which answered the polling signal are made to be performed. Next, the tollgate which has three lanes L1-L3 is made into an example, and the contents of control, the combination of the machines 20a-20c on the street, and the timing 25 of operation, i.e., a timing control section, are explained.

[0082] First, in the tollgate M1 shown in drawing 10 (a), with lanes L1 and L2, common on the street machine 20a is installed in lanes L1 and L2, on-the-street machine only for passive 20c is installed in a lane L3, and the communications area for active methods by the antenna 21 and the communications area for passive methods by the antenna 23 are detached spatially, and moreover, they are set up so that it may not overlap mutually. However, all over drawing, only the antenna is indicated among the configurations of each machine on the street (even the following, drawing 11 , and drawing 12 are the same).

[0083] moreover -- common on the street machine 20a of a lane L1 -- the object for a passive communication link -- a frequency band Fp1 and the object for an active communication link -- in common on the street machine 20a of a frequency band Fa2 and a lane L2, a frequency band Fp3 is assigned to a passive communication link a frequency band Fp2 and for an active communication link, and is assigned to the passive communication link in on the street [only for passive] machine 20c of a frequency band Fa1 and a lane L3.

[0084] In addition, one period (henceforth the "active section") of the frame used by the active method and one period (henceforth the "passive section") until it stops sending out of a subcarrier after sending-out initiation of a polling signal or a querying signal by the passive method are set as the same die length.

[0085] And all, the timing control section 25 of each common on-the-street machine 20a of lanes L1 and L2 controls the timing of both the communications departments 22 and 24 of operation to be shown in drawing 10 (b) so that the sending-out timing of a polling signal or a querying signal differs from the sending-out timing of FCM in the same lane.

[0086] Moreover, the timing control section 25 of each machine 20 of lanes L1-L3 on the street controls the timing of each communications departments 22 and 24 of operation so that it interlocks, and the sending-out timing of a polling signal or a querying signal differs mutually with lanes L1 and L3 and a lane L2 and the sending-out timing of FCM differs mutually with a lane L1 and a lane L2.

[0087] In the tollgate M1 constituted as mentioned above, with the lanes L1 and L2 which use common on-the-street machine 20a Since the communications area of an active method and the communications area of a passive method are separated spatially and interference is made not to be caused mutually active and passive -- tariff automatic **** the mounted vessel of which communication mode could secure good communication link quality, and did not twist it to the communication mode of a mounted vessel, but it minded the communication link between highway and vehicle can be performed certainly.

[0088] In addition, in the above-mentioned tollgate M1, although what does not overlap mutually the frequency band assigned to the active method and passive method of the same lane is chosen and combined with the lanes L1 and L2 which use common on-the-street machine 20a, what overlaps mutually may be chosen and combined. That is, when the communications area is separated spatially in this way, the combination of the frequency band of both the communication modes in common on-the-street machine 20a is arbitrary.

[0089] Next, in the tollgate M2 shown in drawing 11 (a), into a lane L1, on the street [only for passive] machine 20c is installed in common on the street machine 20a and a lane L2, on-the-street machine only for active 20b is installed in a lane L3, and moreover, with the lane L1, the communications area for active methods by the antenna 21 and the communications area for passive methods by the antenna 23 are set up so that it may overlap mutually.

[0090] moreover -- common on the street machine 20a of a lane L1 -- the object for a passive communication link -- a frequency band Fa2 is assigned to a passive communication link in on the street [only for passive] machine 20c of a frequency band Fa1 and a lane L2, and is assigned to the frequency band Fp4 and the active communication link for the active communication link by on the street [only for active] machine 20b of a frequency band Fp1 and a lane L3. In addition, the active section and the passive section are set as the same die length like the case of the tollgate M1 explained previously. And to be shown in drawing 11 (b), juxtaposition actuation of both the communications departments 22 and 24 is carried out, and the timing of both the communications departments 22 and 24 of operation is controlled by the timing control section 25 of common on-the-street machine 20a of a lane L1 so that the sending-out timing of a polling signal or a querying signal and the sending-out timing of FCM moreover become simultaneous.

[0091] Moreover, the timing control section 25 of each machine 20 of lanes L1-L3 on the street interlocks, and it is with lanes L1 and L3 and a lane L2, and it controls the timing of each communications departments 22 and 24 of operation so that the sending-out timing of a polling signal or a querying signal differs from the sending-out timing of FCM mutually. active and passive [with the lane L1 which uses common on-the-street machine 20a,] in the tollgate M2 constituted as mentioned above, since the same communications area is used in frequency division by the active method and the passive method and interference is made not to be caused mutually -- tariff automatic **** the mounted vessel of which communication mode could

secure good communication link quality, and did not twist it to the communication mode of a mounted vessel, but it minded the communication link between highway and vehicle can perform certainly.

[0092] Moreover, in a tollgate M2, since the same communications area is used by the active method and the passive method, the communications area of both communication modes can make a facility small as compared with the tollgate M1 separated spatially. In addition, in the above-mentioned tollgate M2, although a frequency band Fp4 is used for a passive communication link and the frequency band Fa1 is used for the active communication link in common on the street machine 20a of a lane L1 in which both communication modes are possible When a frequency band Fa1 is used for an active communication link since it is good if frequency bands do not overlap When frequency bands Fp2 and Fp3 may be used for a passive communication link and a frequency band Fa2 is used for an active communication link, frequency bands Fp1 and Fp4 may be used for a passive communication link.

[0093] Next, in the tollgate M3 shown in drawing 12 (a), common on the street machine 20a is installed in lanes L1 and L2, on-the-street machine only for passive 20c is installed in a lane L3, and moreover, with lanes L1 and L2, the communications area for active methods by the antenna 21 and the communications area for passive methods by the antenna 23 are set up so that it may overlap mutually.

[0094] moreover -- common on the street machine 20a of a lane L1 -- the object for a passive communication link -- a frequency band Fp1 and the object for an active communication link -- in common on the street machine 20a of a frequency band Fa2 and a lane L2, a frequency band Fp4 is assigned to a passive communication link a frequency band Fp2 and for an active communication link, and is assigned to the passive communication link in on the street [only for passive] machine 20c of a frequency band Fa1 and a lane L3. In addition, the active section and a passive period are set as the same die length like the case of the tollgate M1 explained previously. And all, the timing control section 25 of each common on-the-street machine 20a of lanes L1 and L2 controls the timing of both the communications departments 22 and 24 of operation to use it, carrying out time sharing of the same communications area to be shown in drawing 12 (b) so that the active section and the passive section appear by turns.

[0095] Moreover, the timing control section 25 of each machine 20 of lanes L1-L3 on the street interlocks, and it is with lanes L1 and L3 and a lane L2, and it controls the timing of each communications departments 22 and 24 of operation so that the sending-out timing of a polling signal or a querying signal differs from the sending-out timing of FCM mutually.

[0096] In the tollgate M3 constituted as mentioned above, with the lanes L1 and L2 which use common on-the-street machine 20a Since the same communications area is used in time sharing by the active method and the passive method and interference is made not to be caused mutually active and passive -- tariff automatic **** the mounted vessel of which communication mode could secure good communication link quality, and did not twist it to the communication mode of a mounted vessel, but it minded the communication link between highway and vehicle can be performed certainly.

[0097] Moreover, in a tollgate M3, since the same communications area is used by the active method and the passive method, the communications area of both communication modes can make a facility small as compared with the tollgate M1 separated spatially. In addition, in the above-mentioned tollgate M3, although what does not overlap mutually the frequency band assigned to the active method and passive method of the same lane is chosen and combined with the lanes L1 and L2 which use common on-the-street machine 20a, what overlaps mutually may be chosen and combined. That is, when using a communications area by time sharing in this way, the combination of the frequency band of both the communication modes in common on-the-street machine 20a is arbitrary.

[0098] Moreover, it is controlling so that the active section and the passive section continue, but the timing control section 25 in each above-mentioned example may be controlled so that the blank section which performs neither of the transmission and reception of the methods is inserted among both [these] the sections. By the way, although actuation of both the communications departments 22 and 24 is changed per the active section and passive section unit, i.e., communication link frame, in common on the street machine 20a in the above-mentioned tollgate M3 As shown in drawing 13 (a), for example, in the active communications department 22 One of MDS with two or more the communication link frames (here MDS0) is made into a disable. In the passive communications department 24 The die length of the passive section may be set as the magnitude settled in one MDS, and you may constitute from a timing control section 25 so that the passive communications department 24 may be operated at the period of this MDS0.

[0099] In addition, the number of MDS assigned in order to operate the passive communications department 24 As two or more pieces are sufficient, for example, it is shown in drawing 13 (b), among MDS (here eight pieces) by which the multi-statement was carried out in the active communications department 22 MDS of the moiety

located in the eventh (0, 2, 4, 6) is made usable, and MDS of the remaining moieties located in the oddth (1, 3, 5, 7) is made into a disable. In the timing control section 25 The period of MDS made into this disable may be alike, respectively, and you may constitute so that the passive communications department 24 may be operated.

[0100] Furthermore, the number of MDS assigned in order to operate the passive communications department 24 may be constituted so that an adjustable setup may be carried out according to a communication link condition. In this case, it explains along with the flow chart which shows the MDS allocation processing performed in the data-processing section 26 to drawing 14 . However, actuation of the active communications department 22 and the passive communications department 24 is completely the same as that of what was explained with the flow chart of drawing 7 - drawing 9 .

[0101] When this processing starts like illustration, by the active method the number CA of the mounted vessels under current communication link By the active method smaller (CA<SAmax) than the maximum number SAmax (here 2) in which a broadcast is possible If it judges whether there is empty MDS with possible making the communication link of a new active method start (S910) and there is empty MDS, it will judge whether there are any response data (communication link demand of an active method) of ACTS memorized in S540 of the point (S920).

[0102] If there are response data of ACTS, the communication link demand which newly assigns MDS for a SAmax-CA individual as a limit will be chosen from the inside (S930), and on the other hand, if there are no response data of ACTS, it will judge whether it is that there is a thing under current communication link (CA>=1) (S940). In addition, if selection of a communication link demand is performed in S930, only the part will increase the number CA of the mounted vessels under communication link.

[0103] And since there is a thing under current communication link, or at least one has the communication link of the active method which should assign MDS with the communication link frame transmitted to a degree when it is vacant in S910 of the point, and is judged with there being no MDS or a communication link demand is chosen in S930 of the point, MDS which should be used to these communication links (identified by Car ID) is assigned (S950).

[0104] If allocation of this MDS is completed, or it judges whether "under the passive communication link" is set up as a condition of the passive communications department 24 this time when it is judged with there being nothing under current communication link by the active method in S940 of the point (S960) and "under the passive communication link" is set up, it will judge whether it is that there is empty MDS (CA<SAmax) (S970).

[0105] And when "under the passive communication link" is set up and there is no empty MDS inside, basic allocation which assigns one MDS beforehand secured to the passive communication link is performed (S980), and this processing is ended. On the other hand, when "under the passive communication link" is set up and there is empty MDS, extended allocation which assigns some of empty MDS (here, let two pieces be an upper limit) to a passive communication link is performed, and this (S990) processing is ended.

[0106] Drawing 15 always secures one MDS to the communication link in a passive method among three MDS which constitutes a communication link frame, and expresses the condition of the communication link frame at the time of setting to 2 (= SAmax) the maximum number of MDS which can be assigned to the communication link in an active method here. When there is no communication link with a passive method or all MDS that can be assigned to a communication link with an active method is assigned to the communication link with an active method by performing the above-mentioned MDS allocation processing, only one MDS is assigned to a passive communication link as shown in (a). Moreover, when MDS which there is a communication link with a passive method, and was assigned to the communication link in an active method is one or less piece, two MDS will be assigned to a passive communication link as shown in (b).

[0107] Since this is used effectively for a communication link with a passive method when [that it is vacant and there is MDS] not used for a communication link with an active method by performing such MDS allocation processing, the throughput of common on-the-street machine 20a can be raised. In addition, when there is no communication link by the active method, you may make it assign all MDS to a communication link with a passive method here, although the maximum number of MDS which can be assigned to a communication link (passive communications department 24) with a passive method was set to 2.

The [3rd operation gestalt], next the 3rd operation gestalt are explained.

[0108] Drawing 16 is a block diagram showing the configuration of the machine on the street formed for every lane of the tollgate of a turnpike in the communication system between road and car of this operation gestalt with which the mounted vessel which performs a communication link between highway and vehicle by the active method, and the mounted vessel which performs a communication link between highway and vehicle by the passive method are intermingled. Like illustration, the machine 30 on the street is equipped with transmitting antenna 31a for passive methods,

receiving-antenna 31b, and the transceiver antenna 32 for active methods in this operation gestalt. And the directional coupler 33 which separates the transceiver signal over the transceiver antenna 32, With the common communications department 35 as road-side means of communications which performs the communication link between highway and vehicle with a mounted vessel by sending and receiving a signal through these antennas 31a, 31b, and 32 While supplying the sending signal from the common communications department 35 to either of the transceiver antennas 32 through transmitting antenna 31a or a directional coupler 33 according to the change signal G from the common communications department 35 The antenna change section 34 which supplies either of the input signals from the transceiver antenna 32 through receiving-antenna 31b or a directional coupler 33 to the common communications department 35, It was constituted centering on the well-known microcomputer, and has the data-processing section 36 which performs processing of the data sent and received by the common communications department 35 between mounted vessels etc.

[0109] And in the communication system between road and car of this operation gestalt, it is not concerned with an active and passive communication mode, but the common communication link frame which used the thing of an active method as the base is used for the communication link between highway and vehicle between the machine 30 on the street and a mounted vessel. As this communication link frame is shown in drawing 17 , the following modification is added to FCM, two or more MDS (here four pieces), and the conventional communication link frame that consists of ACTS. That is, by dividing ACTS into a part a part for the first portion, and the second half, receiving the response (communication link demand) from the mounted vessel of an active method in a part for the first portion, and transmitting a subcarrier in a part in the second half, it is possible to receive the response (response of as opposed to [consider that FCM is a polling signal and] the polling) from the mounted vessel of a passive method, and it is made.

[0110] moreover, in MDS which made it possible to assign MDS to both a communication link with an active method, and a communication link with a passive method, and was assigned to the communication link in a passive method By getting down and transmitting a subcarrier during the remaining periods of the MDS after transmission of a command (what communalized the MDS command of an active method, and the querying signal of a passive method), it is possible to receive the response from the mounted vessel of a passive method, and it is made.

[0111] And it communicates by the same approach (only a part for the first portion [However the communication link demand from a mounted vessel] of ACTS use) as usual, and on the other hand, the mounted vessel of a passive method considers that FCM is a polling signal, returns the reply signal over a polling signal in the second half part of ACTS, and communicates with the mounted vessel of an active method henceforth using assigned MDS.

[0112] In addition, only the period of MDS assigned to the communication link in a passive method and the second half part of ACTS choose the antennas 31a and 31b for passive, and the common communications department 35 consists of other periods so that the antenna 32 for active may be chosen, and the change signal X which operates the antenna change section 34 may be generated.

[0113] Here, it explains along with the flow chart which shows the actuation about transmission and reception of the communication link frame in the common communications department 35 to drawing 18 . However, since the contents only differ from actuation (refer to drawing 7) of the active communications department 22 of the 2nd operation gestalt in part, about the same processing, they attach the same sign, omit explanation and explain it focusing on the part from which processing is different.

[0114] Like illustration, the response from transmission (S510) of FCM, the processing (S520) for every MDS mentioned later, and the mounted vessel of the active method in ACTS timing is processed in the common communications department 35 (S530, S540). However, the data-processing section 26 shall be read as the data-processing section 36 about S510-S540 in the 2nd operation gestalt among explanation, and the active communications department 22 shall read it as the common communications department 35.

[0115] It judges whether succeedingly, only the predetermined period (second half part of ACTS) transmitted the subcarrier (S550), and had the response (what modulated the subcarrier by the response data to polling) from the mounted vessel of a passive method (S560). And if there is no response, this processing will be ended as it is, the response data (car ID) is memorized in the predetermined area of the memory which constitutes the data-processing section 36 when there is a response on the other hand, and this (S670) processing is ended.

[0116] Next, it explains along with the flow chart which shows the detail of the MDS processing in S520 to drawing 19 . This processing shall be repeatedly performed for every timing of each MDS. If this processing is started like illustration, it is based on the response data memorized in S540 and S570 of the point. The condition of MDS set as the object of current processing as a result of the MDS allocation processing

which the data-processing section 36 performs active or passive -- if it judges whether it is [slot] "under use" (S610) and is not [slot / be / it] "under use", this processing will be ended as it is. [which was assigned to the communication link with one of methods] On the other hand, to the timing of the MDS, if the condition of the MDS concerned "is slot using it", when [which was set up beforehand] it gets down, a command is transmitted (S620) and the MDS concerned is assigned to the communication link of a passive method (S622-YES), succeedingly, only the remaining periods of the MDS concerned will transmit a subcarrier (S624), and will receive the response data from a mounted vessel (S630).

[0117] Hereafter, processing is performed about the received response data like S640-S700 in the MDS processing explained with the 2nd operation gestalt. However, in S670 and S700, when a passive communication link is completed, a setup "under passive communication link" shall be canceled. Moreover, in a publication with the 2nd operation gestalt, it shall get down from the MDS command and the data-processing section 26 shall be read as a command again at the data-processing section 36.

[0118] In addition, in the above-mentioned processing, S550 and S624 are equivalent to the subcarrier transmitting means in this invention. Next, it explains along with the flow chart which shows the MDS allocation processing which the data-processing section 36 performs to drawing 20 .

[0119] In addition, in MDS allocation processing (refer to drawing 14) in which it explained with the 2nd operation gestalt, in order to enable polling to the mounted vessel of a passive method, at least one MDS is always assigned, but with this operation gestalt, in order to perform processing which is equivalent to polling in FCM and ACTS, it differs in that also in the case of a passive method MDS is assigned only when a communication link is started.

[0120] If this processing is started, and it judges whether a setup "under passive communication link" is made (S900) and is not [passive / be / it] "under communication link", [which shows that the communication link with a mounted vessel is first performed by the passive method like illustration] If it judges whether there is any communication link demand with whether the response data to polling are memorized in S570 of the point and a passive method (S902) and there is a communication link demand with a passive method While choosing from the inside only one thing which starts a communication link, a setup "under passive communication link" is performed (S904).

[0121] And it progresses to degree step, without securing MDS, when it is judged with it passive being "under communication link" in S900, or "under a passive communication link" is newly set up in S904, and MDS of minimum (here one piece) is secured (S906), and it is not, and "it is not passive communicating" on the other hand to the communication link in a passive method and there is also no communication link demand with a passive method in it.

[0122] Hereafter, S910-S950 assign MDS used for a communication link with an active method like explanation with the 2nd operation gestalt. However, in this operation gestalt, if MDS is not secured for the number of maximum MDS which can be assigned to the communication link in an active method for the communication link in a passive method by S906, SAmax is SAmax =4, and if secured, only the part will decrease and it will be set to SAmax =3.

[0123] It judges whether after allocation of MDS for passive methods is completed, "under the passive communication link" is set up (S960), and judges whether if not set up, this processing is ended as it is, there is empty MDS in addition to MDS secured in S906 of the point when set up on the other hand, or there is any total of two or more MDS which is not assigned to active methods (S970). And if there is no empty MDS, basic allocation which assigns one MDS secured to passive methods will be performed (S980), this processing will be ended, extended allocation which also assigns empty MDS to passive methods when there is empty MDS on the other hand will be performed, and this (S990) processing will be ended. By the way, although the mounted vessel of a passive method needs to change processing by having communalized the communication link frame by the active method and the passive method in this way, the processing becomes the almost same thing as the active communications department 22 shown in drawing 3 .

[0124] However, transmission of the response data of S250 and S280 is performed in modulating a subcarrier, and for every assigned MDS, processing of S260-S300 has the need so that it may carry out repeatedly. Thus, S250 and S280 which were improved are equivalent to the 1st response means in this invention, and the 2nd response means, respectively.

[0125] As mentioned above, since according to the communication system between road and car of this operation gestalt the machine 30 on the street cannot be concerned with an active and passive communication mode but can process systematically as explained, it is not necessary to prepare the communications department according to individual for every communication mode, and the configuration of the machine 30 on the street can be simplified.

[0126] In addition, as for the field strength of the electric wave from the mounted vessel which a machine on the street receives, it is desirable to constitute from a

passive method in the common communications department 35 so that the amplification factor of the amplifier which amplifies the input signal may be increased, in case a signal is received from receiving-antenna 31b for passive methods since it is a very small thing as compared with the active method. Of course, conversely, in case a signal is received from the transceiver antenna 32 for active methods, you may constitute so that the amplification factor of amplifier may be reduced.

[0127] Moreover, although ACTS is divided into a part a part for the first portion, and the second half, the response of both active and passive communication modes is shifted in time and he is trying to be received with this operation gestalt, as long as the frequency band of an up link of an active method differs from the frequency band which transmits the subcarrier of a passive method, a subcarrier may be sent out over between the whole term of ACTS, and a response may be received to coincidence. However, it is necessary to receive the signal of two kinds of frequency bands to coincidence, and in this case, it is necessary to constitute from a period of ACTS at least so that the signal of those both may be processed.

The [4th operation gestalt] The 4th operation gestalt is explained below.

[0128] Drawing 23 is a block diagram showing the configuration of the mounted vessel which can communicate with any machine on the street in the communication system between road and car with which the machine on the street which offers ETC application by the active method or the passive method, and the machine on the street which offers applications other than ETC by the active method are intermingled.

[0129] In addition, in the communication link between highway and vehicle of an active method and a passive method, it is not based on the class of application but the same communication link frame (refer to drawing 22) as what was explained with the 1st operation gestalt is used. However, an offering-by the communication link between highway and vehicle of active method-ETC application machine on the street As shown in drawing 21 , the object for down links, and the frequency bands Fad1 and Fau1 (it is Fa1 when naming two generically) of the pair for an up link, Or the machine on the street which performs a bidirectional communication link using Fad2 or Fau2 (similarly Fa2), and offers ETC application by the communication link between highway and vehicle of a passive method performs a bidirectional communication link using either of four frequency bands Fp1-Fp4 used bidirectionally.

[0130] Moreover, it is made for the machine on the street which provides the communication link between highway and vehicle of an active method with applications other than ETC to have the bidirectional communication link performed using either of the frequency bands Fedj and Feuj of the object for down links, and the pair for an up link (j=1-5). In addition, the machine on the street which offers applications other than ETC shall be installed in locations which the car has stopped completely or are forced extremely migration at a low speed, such as a parking lot, near the entrance of a public facility, and near the parking location of the car in a parking lot, near the transit way in a parking lot, and shall offer close leaving management and customer service.

[0131] As shown in drawing 23 , like the mounted vessel 10 of the 1st operation gestalt, the mounted vessel 40 of this operation gestalt was equipped with an antenna 41, the field strength detecting element 42, the active communications department 43, the passive communications department 44, and the data-processing section 45, and is further equipped with the memory 46 which stores the frequency allocation information mentioned later and machine information on the street.

[0132] Among these, the active communications department 43 is not concerned with the object for ETC applications, and applications other than ETC, but it is constituted so that the communication link with a machine on the street may be performed using either of a pair each of frequency bands Fa1, Fa2, Fe1-Fe5 for active methods.

[0133] The passive communications department 44 is constituted by the existence of reception of a communication link frame so that two frequency bands can be judged to coincidence, while any one of the frequency bands Fp1-Fp4 for passive methods is used and a passive method performs the communication link with a machine on the street through an antenna 41. However, with this operation gestalt, only three frequency bands Fp1-Fp3 shall be used among four frequency bands Fp1-F4 for passive methods.

[0134] As shown in drawing 21 , the field strength detecting element 42 is constituted by the frequency bands Fed1-Fed4 used for the communication link of an active method, or the frequency bands B1-B7 which were set up so that it might be in agreement with Fad1, Fed5, and Fad2, respectively so that the field strength may be measured. Therefore, when the field strength of frequency band B5 is measured, the field strength of frequency band B6 is measured relating with frequency bands Fad1 and Fp1 and the field strength of a frequency band B7 is measured relating with frequency bands Fp1 and Fp2, frequency bands Fad2, Fp2, and Fp3 will be related.

[0135] That is, with this operation gestalt, it becomes possible by measuring frequency band B5 and the field strength of B7 to detect the busy condition of all the frequency bands Fad1, Fad2, Fp1-Fp3 for ETC applications. Below, this frequency band B5 and B7 are also called an ETC frequency band.

[0136] The active communications department 43 and the passive communications

department 44 match and indicate a communication mode (an active method / passive method), the class (ETC/in addition to this) of application, and a modulation technique (ASK/PSK/QPSK) to be the frequency allocation information memorized by memory 46 for each [which is used for the communication link with a machine on the street] frequency band of every. Moreover, machine information on the street shows using which frequency band the machine on the street which was classified beforehand and which is contained for every area in the area offers application. In addition, an area can set up one area for every machine on the street, or can set up fields where penetration of a car is restricted, such as a highway, as one area.

[0137] The data-processing section 45 is constituted centering on a well-known microcomputer, controls each part 42, 43, and 44 of the above based on the frequency-allocation information and the machine information on the street which were memorized by memory 46 while inputting the positional information which expresses the current position of a car from navigation equipment etc., and the rate information showing the travel speed of ECU which processes the output signal of a speed sensor to a car, and performs processing of the data obtained by the communication link with a machine on the street etc.

[0138] Here, it explains along with the flow chart which shows the Maine processing which the data-processing section 45 performs to drawing 24 . If the frequency scan for specifying the frequency band which the machine on the street is using for offer of service using the field strength detecting element 12 first if this processing starts is performed (S1010) and a frequency is specified with a frequency scan While setting the modulation technique of the active communications department 13 and the passive communications department 14 as the thing corresponding to the specified frequency band based on the frequency allocation information memorized by memory 46 It judges whether it is ETC frequency band B5 and either of B7 which were prepared in order that it might offer ETC application (S1020).

[0139] If the specified frequency is an ETC frequency band, it will judge whether the method currently used for the communication link is an active method in which communications departments 13 and 14 have analyzed the communication link frame from the output of the active communications department 13 and the passive communications department 14 (S1030). And ETC processing with the active method which used the active communications department 13 when the method currently used for the communication link was an active method is performed (S1040), and ETC processing with the passive method which used the passive communications department 14 when return and the method currently used for the communication link were passive methods on the other hand is performed to S1010 (S1050), and it returns to S1010.

[0140] the frequency band specified with a frequency scan in S1020 of the point -- the thing of an ETC frequency band -- **** -- **, when judged The application ID in a part for the header unit of the frame received through the active communications department 13 is extracted. Judge whether based on this application ID, the application which the machine on the street offers can process with the mounted vessel concerned (S1060), and if processing is not possible Then, on the other hand, if it is return and the thing which can be processed, the application process corresponding to Application ID will be performed to S1010 (S1070), and it will return to it S1010.

[0141] Next, it explains along with the flow chart which shows the detail of the frequency scan performed in S1010 to drawing 25 . Total Umax of the unit unit which acquires the positional information showing the current position of a car (S1110), reads the machine information on the street on an area that it corresponds from memory based on the positional information, and constitutes one period of a change pattern and a change pattern from external navigation equipment etc. first according to the machine information on the street if this processing starts (henceforth "the number of units") It sets up (S1120).

[0142] Here, drawing 26 (a) shows the change pattern set up when judged with measurement being required about all frequency bands from machine information on the street, and is the number Umax of units. It is 15. Whenever it is two unit units and performs ETC frequency band B5 and measurement of B7, it is one unit unit and, specifically, one measurement of the other frequency bands Fed1-Fed5 is performed in order. That is, when the application which a machine on the street offers is ETC application, the frequency band used is specified within 3 unit unit, and it is made for the mounted vessel 40 to have ETC application started.

[0143] Moreover, drawing 26 (b) shows the change pattern set up when judged with it being in the area where any applications other than ETC application are not offered from machine information on the street, and is the number Umax of units. It is 2. Since it is not necessary to measure frequency bands Fed1-Fed5, specifically, only ETC frequency band B5 and measurement of B7 will be repeated and performed.

[0144] And counted value i of the counter for counting the number of units is initialized to 1 (S1130), and the rate information showing the travel speed of a car is acquired from ECU which processes the signal from a speed sensor (S1140). According to this rate information, a unit unit is set [as shown in drawing 26 (c),] up

so that a travel speed is early, and a unit unit hour may become short (S1150), and the timer for measuring this unit unit hour is started (S1160).

[0145] Next, based on counted value i, the field strength of the frequency band corresponding to the i-th unit unit in a change pattern is measured (S1170), and it judges whether it is more than the lower limit to which the field strength was set beforehand (S1180). And if field strength is smaller than a lower limit, if the timer started in S1160 of the point has not judged and (S1190) carried out the time-out of whether the time-out was carried out, it will return to S1170, and measurement of field strength will be repeated. On the other hand, if it judges whether it moved beyond predetermined distance (S1200) and is moving beyond predetermined distance from the point of the positional information acquired in S1110 of the point when the timer is carrying out the time-out, it will return to S1110, acquisition of positional information and resetting of a change pattern will be performed, and measurement of field strength will be repeated.

[0146] moreover -- the case where it is not moving beyond predetermined distance -- counted value i of a counter -- incrementing (S1210) -- counted value i -- the number Umax of units of a change pattern a ****** [being large] -- judging (S1220) -- the number Umax of units if large, after initializing counted value i of a counter to 1 (S1230) -- S1140 -- return -- on the other hand -- the number Umax of units the following -- be -- ** -- it remains as it is -- it returns to S1140 without doing anything.

[0147] If it is more than the lower limit to which the field strength obtained by measurement in S1180 of the point was set beforehand, the center frequency of the frequency band corresponding to the i-th unit will be memorized as a detection frequency (S1240), and this processing will be ended. By the way, a unit unit hour is set up as follows. That is, if magnitude of the communications area of V [m/s] and a machine on the street is set to s [m] for the travel speed of a car, a car can express with (1) type the duration tp which passes through a communications area.

[0148]

tp=s/V[s] (1)

Usually, in this duration tp, including a retry, all the amounts of data are set up so that about 3 times of a series of communication links required for offer of application may be possible. It is tp=500[ms] when [in the case of s= 5 [m]] V= 10 [m/s] (= 36 [km/h]). For example, time amount usable for application offer If [it is set to about 170 [ms] (= tp/3) and] V= 30 [m/s] (= 108 [km/h]), it will be tp=167[ms] and time amount usable for application offer will be set to about 50 [ms].

[0149] And a unit unit hour is determined so that one period of a change pattern may consist of a maximum of 15 unit units as mentioned above, and one period of this change pattern may become small enough to the time amount 50-170 usable for application offer [ms]. For example, 1 [ms], then a unit unit hour serve as 1/15 [ms] extent in one period of a change pattern.

[0150] In addition, in applications other than ETC, since the communication link by super-low ** during a stop is the requisite, since time amount usable for application offer is secured per second, even if it sets up a change pattern and a unit unit hour focusing on ETC application as mentioned above, it can secure sufficient processing time.

[0151] this operation gestalt -- setting -- S1170 -- a rate acquisition means and memory 46 are equivalent to a storage means, and S1120 is [a field strength measurement means, and S1210-S1230 / a frequency change means and S1110] equivalent to a change pattern setting means for a reference-by-location speciality stage and S1140. As explained above, with the mounted vessel of this operation gestalt, the frequency band with which the machine on the street is using the frequency bands B1-B7 set up beforehand for offer of application by carrying out a sequential search according to a change pattern is specified, and moreover, the change pattern is set up so that the frequency of occurrence of an ETC frequency band may become high.

[0152] Therefore, according to the mounted vessel of this operation gestalt, when it not only can cope with various applications, but ETC application is offered from the machine on the street using many frequency bands, it becomes possible to detect this promptly and to start ETC application promptly. Consequently, it performs, while the car is running comparatively at high speed, and even if the time amount permitted by processing is short ** ETC application, the float for communication link retries, as a result communicative dependability are fully securable.

[0153] Moreover, an area be pinpoint based on the positional information which express the location of a car with the mounted vessel of this operation gestalt, and while set up a change pattern only using the frequency band which the machine on the street in the pinpointed area use, based on the rate information showing the travel speed of a car, the unit unit hour which be the measuring time per [which measure each frequency band] time be change so that it may become so short that a travel speed be early.

[0154] Therefore, the frequency band which the machine on the street is using for offer of application can be specified without futility, and even if it is at the high-speed

transit time, the processing time for activation of application is fully securable according to the mounted vessel of this operation gestalt.

[0155] In addition, in this operation gestalt, it is constituted so that the field strength of any one frequency band may be measured out of the set-up frequency bands B1-B7, but the field strength detecting element 12 may be constituted so that the field strength of two or more frequency bands can be measured to coincidence. Moreover, although a change pattern is changed or a unit unit hour is changed with this operation gestalt according to rate information according to positional information, either or both of a change pattern or a unit unit hour may be immobilization.

[0156] Furthermore, although ETC application is used with this operation gestalt as specific application with which the frequency of occurrence in the inside of a change pattern increases, the application about the electronic number plate which reads car empty vehicle both the information under transit in addition to this may be used as specific application.

[0157] In addition, as applications other than ETC which a machine on the street offers, a machine on the street may be installed in the parking lot of a department store, the WEB page of the department store may be downloaded on a car, and you may use for the service provision in a counter by telling a customer about sale information, event information, etc. on a department store, or making electronic equipment like PDA or a cellular phone memorize the information further.

[0158] Moreover, a machine on the street is installed in the parking lot of a convenience store, and various money payments enable it to be able to do, without getting down from a car, or you may enable it to receive a music distribution and game distribution within a car. Moreover, usage like a simple message board may be carried out.

[0159] Moreover, a machine on the street may be installed in a parking lot outlet, and you may make it the car which runs near an outlet to tell recession of the car from a parking lot etc. Moreover, you may make it offer real time traffic information and the information (for example, crossing name etc.) for getting to know the current position in various locations with the machine on the street installed near the road.

[0160] Furthermore, it may apply to train traffic control systems, such as a bus, and a taxi or a transportation truck, and you may constitute so that the communication link with the mounted vessel and the machine on the street which were carried by each car may perform transfer of grasp of the operation situation of each car, or an allocation-of-cars situation, the accident information on each car, etc.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] this invention relates to the communication system between road and car with which two methods (passivity -- active) currently used for the communication link between highway and vehicle are intermingled and the mounted vessel which can respond to the various applications through both methods or a communication link between highway and vehicle, and a machine on the street.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] It is DSRC (Dedicated Short Range Communication) as a communication mode for realizing tariff automatic **** (ETC) in a turnpike etc. by conventionally performing two-way communication between the mounted vessel carried in the car, and the machine on the street installed near the transit way of a car. It is known. In this communication mode, the passive method (it adopts in Europe, China, and Southeast Asia) which performs transmission of the going-up signal of two methods, i.e., the machine on the street from a mounted vessel, by modulating and returning the subcarrier from a machine on the street to a mounted vessel which gets down and is transmitted after a signal, and the active method (it adopts in Japan) with which a mounted vessel performs transmission of an uphill signal autonomously using a frequency band which gets down and is different from a signal exist.

[0003] For this reason, even if the road continues, the communication mode currently used for ETC on the boundaries (border etc.) which change political jurisdiction and law can change to an active method (or that reverse) from a passive method, or it is possible that the machine of a formula on the street is intermingled and is both arranged in the area which faced across the above-mentioned boundary in the future.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] And since a communication link was impossible with the machine on the street from which it will not only be spoiled, but [when the convenience that tariff **** can be performed without suspending a car by the car only carrying the mounted vessel corresponding to one of methods crosses the above-mentioned boundary,] a communication mode differs in the case of the former, there was a problem that it may be dealt with as a violation car by such machine on the street.

[0005] Moreover, since some frequency bands to be used overlapped mutually by the active method and the passive method in the case of the latter, interference arose, communication link quality deteriorated and there was a problem that there was a possibility that communicating may become impossible. As a slash shows to drawing 21 , namely, to an active method The frequency bands Fad1, Fad2, Fau1, and Fau2 which are four whose bandwidth which makes center frequency 5795MHz, 5805MHz, 5835MHz, and 5845MHz is 5MHz To the object for the going-down signals from a machine on the street to a mounted vessel (Fad1, Fad2), and the going-up signals (Fau1, Fau2) from a mounted vessel to a machine on the street Two are assigned at a time, respectively. On the other hand, to a passive method 5797. The frequency bands Fp1-Fp4 which are four whose bandwidth which makes center frequency 5 MHz, 5802.5 MHz, 5807.5 MHz, and 5812.5 MHz is 5MHz are assigned to the bidirectional communication link by each. Therefore, in Fad1 of an active method, Fp1 of a passive method and Fad2 of an active method may cause Fp2, Fp3, and interference of a passive method.

[0006] By the way, by recent years, it considers offering the new application which used the DSRC communication link in the communication link frequency band of a 5.8GHz band using the frequency band which is not used for ETC. In this case, a frequency band which is different from the active method of the existing ETC as shown in drawing 21 , The frequency bands Fed1-Fed5 which are ten pieces whose bandwidth which makes center frequency 5775MHz, 5780MHz, 5785MHz, 5790MHz, 5800MHz, 5815MHz, 5820MHz, 5825MHz, 5830MHz, and 5840MHz, respectively is 5MHz The thing from (on-the-street machine to a mounted vessel for which it gets down and) for signals, and Feu1-Feu5 (for the going-up signals from a mounted vessel to a machine on the street) are used is planned.

[0007] Therefore, to constitute so that a mounted vessel can respond not only to the existing ETC but to these new applications will be demanded from now on. That is, the function which chooses the application which performs a mounted vessel based on the frequency band of not only the function to identify an active method and a passive method but the received electric wave is needed.

[0008] while the communication link had gone wrong by designing a system so that a communicative retry might become possible when a communication link went wrong in order to secure the dependability of a system by ETC especially, the probability for a

car to pass through a communications area becomes small enough (it is one or less set to 1 million sets) -- it is made like.

[0009] The time amount to which a car passes through a communications area at a setting car rate (assumption full speed) was specifically set as about 3 times of the time amount taken [after the frequency band used is specified] to complete ETC processings (authentication, store to a card, etc.), and sufficient float is secured.

[0010] However, with the mounted vessel which can respond to all of ETC application and new application, as compared with what performs only ETC application, it will have to look also for five frequency bands too much, and specification of the frequency band used took time amount, consequently the float for communication link retries will be deleted, and there was a problem of reducing communicative dependability.

[0011] the mounted vessel which can cope with all of two methods (activeness -- passive) used by communication link between highway and vehicle in order that this invention may solve the above-mentioned trouble, and a machine on the street -- And set it as the 1st purpose to offer a communication system between road and car, and further, without reducing the dependability of specific applications, such as ETC which must complete processing within the limited time amount It sets it as the 2nd purpose to offer the mounted vessel which can cope with various applications.

[Translation done.]

* NOTICES *

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MEANS

[Means for Solving the Problem] With the mounted vessel according to claim 1 which is invention for attaining the above-mentioned purpose The active method which the 1st car side means of communications goes up using a received frequency band which gets down and is different from a signal, and transmits a signal autonomously performs the communication link with a machine on the street. The passive method which answers by modulating and returning the subcarrier which is not modulated [which the 2nd car side means of communications receives to the received question signal following this question signal] with a reply signal performs the communication link with a machine on the street.

[0013] And if it advances into the communications area of a machine on the street, a car side change control means will search the car side means of communications which can communicate by operating either of the 1st or 2nd car side means of communications, and changing to another side, if a communication link is impossible. Therefore, according to the mounted vessel of this invention, even if a machine on the street is the model of dedication corresponding to either an active method or a passive method, it can communicate with this certainly.

[0014] in addition, when the frequency band of dedication with which the common use with another side does not become exists by the active method and the passive method in the frequency band to be used The frequency band of the signal transmitted from a machine on the street with a frequency discrimination means like according to claim 2 is identified. A car side change control means As long as the identified frequency band is a frequency band of dedication in one of communication modes, you may make it operate immediately the car side means of communications corresponding to the communication mode.

[0015] In this case, since the search for specifying any can communicate among the 1st and 2nd car side means of communications will be performed only when the frequency band identified with the frequency discrimination means is what both communication modes share, the mean time to communication link initiation can be shortened.

[0016] Next, with a mounted vessel according to claim 3, if it advances into the communications area of a machine on the street, a car side selection-control means carries out juxtaposition actuation of the 1st and 2nd car side means of communications, and the side from which the normal output was obtained will be operated continuously. Therefore, even if a machine on the street is the model of dedication corresponding to either an active method and a passive method, it can communicate with this certainly and, moreover, the communication link with a machine on the street can be made to start by necessary minimum time amount according to the mounted vessel of this invention.

[0017] Although the mounted vessel constituted so far so that any communication mode could be coped with was explained, the machine on the street constituted from below so that any communication mode could be coped with is explained. First, in the machine [according to claim 4] on the street, it had the 1st road-side means of communications which performs the communication link with the mounted vessel of an active method, and the 2nd road-side means of communications which performs the communication link with the mounted vessel of a passive method, and these 1st and 2nd road-side means of communications is set up so that it may be arranged without each communications areas overlapping mutually in accordance with the transit path of a car. Therefore, the car which runs in accordance with a transit path will pass through each of each communications areas of the 1st and 2nd road-side means of communications.

[0018] Thus, since the communications area of both communication modes was separated spatially, though the same frequency band was used by both communication modes according to the machine of this invention on the street, the signal of both communication modes does not cause interference and good communication link quality is secured also to the mounted vessel of which communication mode. Consequently, even if the mounted vessel carried in the car is the thing of dedication in one of communication modes, it can communicate with this certainly.

[0019] Next, in the machine [according to claim 5] on the street, each communications area was in agreement, and moreover, the 1st and 2nd road-side means of communications is set up so that the frequency bands used for each communication link may differ mutually. Thus, according to the machine of this invention on the street, since the signal of both communication modes is separated in frequency, even if the communications area of both communication modes is the same, the signal of both communication modes does not cause interference and good communication link quality is secured also to the mounted vessel of which communication mode. Consequently, even if the mounted vessel carried in the car is the thing of dedication in one of communication modes, it can communicate with this certainly.

[0020] Moreover, next, with the machine [according to claim 6] on the street, the 1st and 2nd road-side means of communications is set up so that each communications area may be in agreement, and the road-side change control means is operating alternatively either of the 1st or 2nd road-side means of communications according to the timing set up beforehand.

[0021] Thus, according to the machine of this invention on the street, since the signal of both communication modes is separated in time, even if the communications area of both communication modes is the same, the signal of both communication modes does not cause interference, and even if it is the mounted vessel of which communication mode, good communication link quality is secured. Consequently, even if the mounted vessel carried in the car is the thing of dedication in one of communication modes, it can communicate with this certainly.

[0022] in addition, as timing to which a road-side change control means changes the road-side means of communications (namely, communication mode) to operate Although you may make it change in the unit of the communication link frame which each uses, for example, like claim 7 publication When what established two or more slots for data is used so that a broadcast with two or more mounted vessels may be possible as a communication link frame of an active method At least one slot for data to which use by the 1st road-side means of communications was forbidden is set up, and you may make it operate the 2nd road-side means of communications at the period of the slot for data.

[0023] Furthermore, a road-side change control means has few mounted vessels of the active method which needs the communication link with a machine on the street like according to claim 8 than the number of the slots for data secured to active methods, and when an opening is in the slot for data, you may make it operate the 2nd road-side means of communications also in this slot period.

[0024] In this case, the slot for data can be used efficiently, a communication link with the passive method which can communicate only with one mounted vessel at a time can be terminated in a short time, and a throughput can be raised. By the way, it is expected that equipment is enlarged although either has the means of communications of activeness and passive both methods, it is not necessary to add modification to the procedure of each communication mode since it is used changing this, and it can constitute from an above-mentioned approach easily conventionally using equipment.

[0025] In order to solve this problem, in a communication system between road and car according to claim 9 The slot for uphill control for a mounted vessel to write in the communication link demand to a machine on the street as a communication link frame for the communication link between vehicles, as shown in drawing 22 (it corresponds to ACTS), Two or more slots for data assigned to the mounted vessel which permits a communication link based on the communication link demand written in this slot for uphill control (it corresponds to MDS), It is sent out ahead of the slot for data, and the

slot for uphill control, and the thing for the active methods which get down and consist of a slot for control (it corresponds to FCM) for a machine on the street to notify the allocation condition of the slot for data to a mounted vessel is used. A machine on the street and the mounted vessel of a passive method are constituted as follows so that a communication link with a passive method may also become possible using this communication link frame.

[0026] That is, a machine on the street transmits the subcarrier non-become irregular to the period of the slot for uphill control, and the period within the slot for data assigned to the mounted vessel of a passive method which gets down and follows a signal, and processes the reply signal returned from the mounted vessel of a passive method in modulating this subcarrier as a thing equivalent to the going-up signal from the mounted vessel of an active method.

[0027] While modulating and returning the subcarrier which is not modulated [which the mounted vessel of a passive method gets down, on the other hand, considers that the slot for control is a polling signal, and is transmitted to the period of the slot for uphill control] with the reply signal over a polling signal When it gets down and allocation of the slot for data over the mounted vessel concerned is shown in the slot for control, it gets down, and a signal is made into a querying signal, and the subcarrier which is not modulated [which is transmitted following on this going-down signal] is modulated and returned with the reply signal over a querying signal received at the period of this slot for quota **** data.

[0028] Thus, since it is possible to carry out the partial change of the processing of a passive method, to enable it to be processed using processing of an active method and a common communication link frame, and to process the communication link with the mounted vessel of both communication modes in common according to the communication system between road and car of this invention, the configuration of the machine on the street which can cope with the mounted vessel of both communication modes can be simplified sharply.

[0029] Moreover, the communication procedure using going up of an active method / commands which it gets down and are used for a signal, and querying/reply signal of a passive method, and these commands is communalized, and processing to these signals can be performed, without being conscious of an active and passive difference.

[0030] In a communication system between road and car according to claim 9 in addition, a road-side machine for example, the communication link frame according to claim 10 which gets down and consists of the slot for control, a slot for data, and a slot for uphill control like -- using -- an active method -- the communication link with a mounted vessel -- carrying out -- obtaining -- road-side means of communications -- in addition A subcarrier transmitting means to transmit the subcarrier non-become irregular to the period of the slot for uphill control and the period within the slot for data assigned to the mounted vessel of a passive method which gets down and follows a signal is established. Road-side means of communications should just constitute the reply signal returned from the mounted vessel of a passive method in modulating a subcarrier so that it may process as a thing equivalent to the going-up signal from the mounted vessel of an active method.

[0031] Similarly, in a communication system between road and car according to claim 9, although the conventional thing can be used for the mounted vessel of an active method as it is Like for example, claim 11 publication, if the mounted vessel of a passive method advances into the communications area of a machine on the street The 1st response means gets down and considers that the slot for control is a polling signal. The subcarrier which is not modulated [which is transmitted to the period of the slot for uphill control] is modulated and returned with the reply signal over a polling signal. When the 2nd response means gets down and allocation of the slot for data over the mounted vessel concerned is shown by the slot for control, What is necessary is to get down, and to make a signal into a querying signal, and just to constitute so that the subcarrier which is not modulated [the / which gets down and is transmitted following on a signal] may be modulated and returned with the reply signal over a querying signal received at the period of the assigned slot for data.

[0032] Next, with a mounted vessel according to claim 12, it is carried in a car for the communication link with the machine on the street installed near the transit path of a car. With a frequency discrimination means to identify the frequency band of the signal received from said machine on the street, a field strength measurement means measures the field strength of the set-up frequency band, and a frequency change means changes the frequency band which serves as the measuring object with this field strength measurement means one by one according to the change pattern set up beforehand.

[0033] However, the change pattern is set up so that the frequency of occurrence of the frequency band assigned to the specific applications which must complete processing in the limited time amount may become high. Thus, since according to the mounted vessel of this invention the detector meeting of the frequency band for specific applications is made [many] and this frequency band is investigated preferentially, when specific application is offered from the machine on the street, it becomes possible to detect this promptly and to start processing promptly.

Consequently, various applications can also be coped with, without fully being able to secure the float for communication link retries, and reducing the dependability of specific application.

[0034] In addition, you may constitute so that the travel speed acquired with a rate acquisition means is early, a unit unit hour may become short and this unit unit hour may be changed, while changing the frequency band which serves as the measuring object for every unit unit hour according to claim 13 to which the frequency change means was set like.

[0035] That is, the time amount taken for a car to pass through a communications area becomes short so that a travel speed is early, but if the time amount which specification of an operating frequency takes by adjusting a unit unit hour in this way is shortened, the time amount assigned to processing is securable. Moreover, machine information including the information about the frequency band which the machine on the street installed in each area according to claim 14 beforehand classified into the storage means like uses for a communication link between highway and vehicle on the street is made to memorize. Based on the machine information on the street memorized by this storage means, a change pattern setting means may narrow down the frequency band which serves as a candidate for retrieval with a frequency discrimination means from the current position acquired in the reference-by-location speciality stage, and it may constitute so that a change pattern may be set up.

[0036] In this case, since it can prevent certainly not measuring vainly the frequency band which the machine on the street is not using, and spending useless time amount on specification of an operating frequency and the processing time can also fully be secured, the dependability at the time of performing specific application can be raised further.

[0037] In addition, that what is necessary is just what processes to the car which passes through a communications area at a comparatively early rate, specific application may be processing according to claim 15 concerning ETC like, and may be processing according to claim 16 concerning an electronic number plate like.

[0038] Moreover, it cannot be overemphasized that invention according to claim 12 to 16 may be combined with invention according to claim 1 to 11.

[0039]

[Embodiment of the Invention] The operation gestalt of this invention is explained with a drawing below.

[1st operation gestalt] drawing 1 is a block diagram showing the configuration of the mounted vessel which can communicate with any machine on the street in the communication system between road and car of the 1st operation gestalt with which the machine on the street which offers ETC application by the communication link between highway and vehicle of an active method, and the machine on the street which offers ETC application by the communication link between highway and vehicle of a passive method are intermingled.

[0040] In addition, in the communication link between highway and vehicle of an active method, and the communication link between highway and vehicle of a passive method, the well-known communication link frame which each shows to drawing 22 shall be used. Namely, in the communication link between highway and vehicle of an active method, it has three message data slots (MDS) so that the broadcast of three sets of mounted vessels may be possible. A frame control message channel for a machine on the street to notify the allocation condition of MDS to a mounted vessel before the MDS (FCM), The communication link frame which consists of an activation slot (ACTS) for a mounted vessel to tell existence to a machine on the street after MDS is used (refer to drawing 22 (a)). In addition, FCM, MDS, and ACTS are equivalent to the slot for going-down control in this invention, the slot for data, and the slot for uphill control, respectively.

[0041] Moreover, in the communication link between highway and vehicle of a passive method, after transmitting a polling signal for a machine on the street to make desired data transmit to a mounted vessel, and a querying signal, only the period set up beforehand succeedingly transmits the subcarrier non-become irregular, and the method of modulating and returning this subcarrier with the reply signal corresponding to a polling signal or a querying signal is used (refer to drawing 22 (b)).

[0042] However, as the column of the conventional technique explained (refer to drawing 21), it sets to an active method. By the down link for the going-down signals from a machine on the street to a mounted vessel, two frequency bands Fau1 and Fau2 are used, respectively by the up link for the going-up signals from two frequency bands Fad1 and Fad2 and a mounted vessel to a machine on the street. A bidirectional communication link is made to be performed using Fad2 or Fau2 [the frequency bands Fad1 and Fau1 (it is Fa1 when naming two generically) of a pair, or] (similarly Fa2). Moreover, by the passive method, four frequency bands Fp1-Fp4 are used, and a bidirectional communication link is made to be performed using any one frequency band.

[0043] Below, the frequency band Fp4 without a lap with other frequency bands is called the frequency band only for passive, and frequency bands Fad1-Fad2 (that is, Fp1-Fp3 are contained) are called a common frequency band. As shown in drawing 1 ,

the mounted vessel 10 of this operation gestalt The field strength detecting element 12 which extracts the signal component of the specified specific frequency band from the input signal received with the antenna 11, and measures the receiving level (field strength), With the active communications department 13 as the 1st car side means of communications which performs the communication link with a machine on the street by the active method through an antenna 11 With the passive communications department 14 as the 2nd car side means of communications which performs the communication link with a machine on the street by the passive method through an antenna 11 It was constituted centering on the well-known microcomputer, each part 12-14 of the above was controlled, and it has the data-processing section 15 which performs processing of the data obtained by the communication link with a machine on the street etc. In addition, although not illustrated, the accounting equipment equipped with IC card reader writer etc. for tariff settlement of accounts is connected to the data-processing section 15.

[0044] It explains along with the flow chart which shows the Maine processing which the data-processing section 15 performs here to drawing 2 . If this processing starts, will output a measurement command to the field strength detecting element 12 first, from the lower cut off frequency of a frequency band Fad1 to the upper limited frequency of a frequency band Fp4 will be made to scan (S110), and it will supervise whether it is more than the lower limit to which the measured field strength was set beforehand (S120).

[0045] If field strength is smaller than a lower limit, it will return to S110 and measurement will be repeated, the frequency at that time is memorized as a detection frequency as that to which the car carrying the mounted vessel 10 concerned advanced into the communications area of a machine on the street when field strength was more than a lower limit (S130), and it judges whether the detection frequency belongs to the frequency band Fp4 only for passive (S140).

[0046] If the detection frequency does not belong to the frequency band Fp4 only for passive, the frequency band with which a detection frequency belongs It specifies out of the frequency bands Fad1 and Fad2 for down links of an active method. The active communications department 13 is set up so that it may communicate using the frequency band Faui for rise rings which becomes the specified frequency band Fadi (i= 1 or 2) and this, and a pair, and (S150) and the communication link between highway and vehicle by the active method are made to start by starting this.

[0047] Then, after judging whether the communication link by the active communications department 13 was completed (S160) and completing a communication link, although the termination receives a signal, it judges whether it is what is depended on the analysis impossible which cannot analyze the contents (S170). And as it is, if communication link termination is not based on analysis impossible, if it is return and the thing to depend on analysis impossible on the other hand, to S110 The frequency band with which the detection frequency memorized in S130 of the point belongs is specified out of the frequency bands Fp1-Fp4 for passive methods. The passive communications department 14 is set up so that it may communicate using the specified frequency band, and (S180) and the communication link between highway and vehicle by the passive method are made to start by starting this.

[0048] Then, after judging whether the communication link by the passive communications department 14 was completed (S190) and completing a communication link, it returns to S110. On the other hand, when it is judged that the detection frequency belongs to the frequency band only for passive in S140, it shifts to S180, and hereafter, the passive communications department 14 is set up and started as explained previously, and the communication link between highway and vehicle by the passive method is made to start. However, a frequency band Fp4 will be used for a communication link in this case.

[0049] In addition, in this processing, S150-S190 are equivalent to the car side change control means in this invention, and S110, S120, and the field strength detecting element 12 are equivalent to a frequency discrimination means. That is, when the communication link between highway and vehicle by the active method is tried at first, an input signal cannot be analyzed, when the communication link between highway and vehicle by the passive method is immediately performed when the detection frequency from which field strength becomes more than a lower limit belongs to the frequency band only for passive in this processing, and it belongs to the other common frequency band, but a communication link goes wrong, it changes to a passive method and a communication link between highway and vehicle is made to be performed.

[0050] Here, it explains along with the flow chart which shows actuation of the active communications department 13 to drawing 3 . If the active communications department 13 starts like illustration, it would judge first whether a certain signal was received through the antenna 11 (S210) and the signal will be received, it will judge whether the signal is FCM (S220).

[0051] And if the contents are analyzed, it judges whether MDS is assigned to the self-car (S230) and it is not assigned when the received signal is FCM, it waits for the

transmit timing of ACTS (S240), and after transmitting the response data for telling a machine on the street about existence of a self-car (mounted vessel 10) (S250), it returns to S210. The identification number (henceforth "Car ID") for specifying the car which carried the mounted vessel 10 concerned or the mounted vessel 10 concerned at least is contained in this response data.

[0052] a ****** [having stood by to the timing of the assigned MDS (S260), having got down to the timing, and having received the signal on the other hand, when MDS was assigned to the self-car (S230-YES), as a result of analyzing the contents of FCM] -- moreover, it judges whether the MDS [which received] command which it gets down and is the contents of the signal is normal (S270).

[0053] And even if it gets down, and it cannot receive a signal or it receives, when abnormalities are in the MDS command, return and as opposed to [on the other hand get down, and / when the MDS command is / that a signal is received / normal] the MDS command response data are transmitted to S210 as it is (S280). If it judged whether a series of communication links according to the procedure set up beforehand were completed (S300) and the communication link was completed by transmission of this response data If actuation of the active communications department 13 is suspended in it and the communication link is not yet completed in it after memorizing the communication link result which shows that the communication link was completed normally in the predetermined area of the memory which constitutes the data-processing section 15 (S310), it will return to it as it is S210.

[0054] When the signal received in S220 of the point is not FCM, according to a format of an active method, it judges whether it is the signal in which analysis is possible (S320), and if analysis is impossible, after outputting the notice of analysis impossible as a reason for termination of communication link termination (S330), actuation of the active communications department 13 will be suspended. In this case, since an affirmation judging is carried out in S180 of the Maine processing explained previously, a communication link between highway and vehicle with a passive method will be tried succeedingly.

[0055] Moreover, although the received signal is not FCM, when it is the signal in which analysis by format of an active method is possible (S320-NO), or when a signal cannot be received (S210-NO) If it judges whether it passed beyond the lock time amount beforehand set as the last after starting the active communications department 13 after receiving FCM (S340) and has not gone through lock time amount yet It returns to S210 then, and on the other hand, if it has passed beyond lock time amount, actuation of the active communications department 13 will be suspended. In this case, it will return to a frequency scan (S110) immediately, without trying a communication link between highway and vehicle with a passive method, since a negative judging is carried out in S180 of the Maine processing.

[0056] Next, it explains along with the flow chart which shows actuation of the passive communications department 14 to drawing 4 . If the passive communications department 14 is started like illustration, it would judge first whether a certain signal was received through the antenna 11 (S410) and the signal will be received, it will judge whether they are normal things, such as a polling signal and a querying signal, (S420).

[0057] If the received signal is not normal, the subcarrier which will be transmitted to it after this on the other hand as it is if return and the received signal are normal to S410 will be modulated with the reply signal currently prepared beforehand, and it will return through an antenna 11 (S430). If actuation of the passive communications department 14 is suspended and the communication link is not yet completed after memorizing a communication link result in the predetermined area of memory (S450), if it judged whether a series of communication links according to the procedure set up beforehand were completed (S440) and the communication link was completed by transmission of this reply signal, it will return to S410 as it is.

[0058] if it judges whether it passed beyond the lock time amount set up beforehand (S460) and has not gone through lock time amount yet on the other hand, after receiving a polling signal or a querying signal at the last after starting the passive communications department 14 when a signal is unreceivable (S410-NO) -- as it is -- S410 -- return -- on the other hand, if it has passed beyond lock time amount, actuation of the passive communications department 14 will be suspended.

[0059] In addition, the reply signal / response data in S430, and S250 and S280 of the point are suitably set up by the application program using the communication link between highway and vehicle separately performed in the data-processing section 15. As explained above, when it has the active communications department 13 in which the communication link between highway and vehicle by the active method is possible, and the passive communications department 14 in which the communication link between highway and vehicle by the passive method is possible and advances into the communications area of a machine on the street in the mounted vessel 10 of this operation gestalt, search actuation which changes both the communications departments 13 and 14 one by one is performed, and the communication link between highway and vehicle with a machine on the street is made to be performed using the direction whose communication link is attained.

[0060] Therefore, according to the mounted vessel 10 of this operation gestalt, even if a machine on the street performs a communication link between highway and vehicle by any of an active method and a passive method, a communication link can be ensured with this. And with this operation gestalt, since the communication link between highway and vehicle by the passive method is made to start immediately when the frequency band which a machine on the street uses for a communication link between highway and vehicle is a frequency band only for passive, without performing search actuation, the mean time required by communication link initiation can be shortened.

[0061] In addition, when the detection frequency detected with a frequency scan belongs to the common frequency band with this operation gestalt, the active communications department 13 is started first. Although the communication link between highway and vehicle by the active method is tried, and it changes to the passive communications department 14 and he is trying to try the communication link between highway and vehicle by the passive method when it is not able to communicate Both the communications departments 13 and 14 are operated to coincidence, and it may be made to communicate by choosing the direction where a normal output is obtained.

[0062] In this case, as shown in drawing 5 , while the Maine processing omits S170 from the flow chart shown in drawing 2 , instead of S150 which starts only the active communications department 13, based on a detection frequency, the frequency band used of both the communications departments 13 and 14 sets it up, and it should just insert S155 which starts both the communications departments 13 and 14.

[0063] Moreover, if lock time amount passes after coincidence starting of both the communications departments 13 and 14 in this case, actuation will be suspended, but when lock time amount is comparatively long, at least one side is a time (S220-YES, S420-YES) of one of the communications departments receiving an effective signal first, and it may be constituted so that actuation of the communications department of another side may be stopped compulsorily. In this case, S155 and the processing which stops the side which cannot communicate are equivalent to the selection-control means in this invention.

[0064] Moreover, although especially processing of what is also omitted with this operation gestalt when lock time amount passes in the active communications department 13 and the passive communications department 14 and actuation is ended, you may make it, operate the alarms (a lamp, buzzer, etc.) formed outside for example.

The [2nd operation gestalt] The 2nd operation gestalt is explained below.

[0065] Drawing 6 is a block diagram showing the configuration of the machine on the street formed for every lane of the tollgate of a turnpike in the communication system between road and car of the 2nd operation gestalt with which the mounted vessel which performs a communication link between highway and vehicle by the active method, and the mounted vessel which performs a communication link between highway and vehicle by the passive method are intermingled. In addition, in drawing 6 , (a) is the common machine on the street which can communicate with any mounted vessel of a communication mode, (b) is the mounted vessel of an active method, and the machine on the street [only for active] which can be communicated, and (c) is the mounted vessel of a passive method, and the machine on the street [only for passive] which can be communicated. Moreover, the communication link frame and the frequency band used for a communication link are the same as that of the case of the 1st operation gestalt.

[0066] With the active communications department 22 as the 1st road-side means of communications which performs the communication link between highway and vehicle with the mounted vessel of an active method through an antenna 21 first as common on-the-street machine 20a is shown in drawing 6 (a) With the passive communications department 24 as the 2nd road-side means of communications which performs the communication link between highway and vehicle with the mounted vessel of a passive method through an antenna 23 The timing control section 25 as a road-side change control means which controls the timing of both the communications departments 22 and 24 of operation, It was constituted centering on the well-known microcomputer, and has the data-processing section 26 in which both the communications departments 22 and 24 perform processing of the data sent and received by the communication link between highway and vehicle with a mounted vessel etc.

[0067] Next, it has the configuration to which on-the-street machine only for active 20b abbreviated an antenna 23 and the passive communications department 24 from common on the street machine 20a as shown in drawing 6 (b), and on-the-street machine only for passive 20c has the configuration which omitted an antenna 21 and the active communications department 22 from common on the street machine 20a, as shown in drawing 6 (c).

[0068] And although it consists of combining suitably and these machines 20 (20a-20c) on the street are not illustrated, the timing control section 25 of each machine 20 on the street consists of tollgates so that it may interlock mutually. Here, it explains along with the flow chart which shows the actuation of the active communications department 22 in the machines 20a and 20b on the street to drawing

7 . In addition, the active communications department 22 starts according to the command from the timing control section 25.

[0069] If the active communications department 22 starts like illustration, MDS processing transmits first FCM to which data were beforehand set by the data-processing section 26 (S510), and send for every MDS and receive data continuously between the mounted vessels to which the MDS was assigned will be performed (S520).

[0070] Then, if it judges whether the response data (car ID) from a mounted vessel were received (S530) and has not received to the timing of ACTS, this processing is ended as it is. On the other hand, if response data are received, Car ID and the number of responses which are the contents of the response data will be memorized in the predetermined area of the memory which constitutes the data-processing section 26 (S540), and this processing will be ended in it.

[0071] MDS allocation processing which assigns MDS in the data-processing section 26 based on the car data and the number of responses which were memorized in these S540 is performed, and while setting up the data transmitted in FCM of the following communication link frame (that is, used in S510), processing of setting up the condition of MDS assigned to the communication link with a mounted vessel "during slot use" is performed.

[0072] Next, it explains along with the flow chart which shows the detail of the MDS processing in S520 of the point to drawing 8 . Repeat (namely, this operation gestalt 3 times) activation of this processing shall be carried out for every timing of each MDS. If the condition of MDS set as the object of current processing will judge whether it is the no which is [slot] "under use" (S610) and "will not slot use [MDS processing is started like illustration, and] it" probably as a result of the MDS allocation processing by the data-processing section 26, this processing will be ended as it is. [be / it] On the other hand, if the condition of the MDS concerned "is slot using it", transmission (S620) of the MDS command currently beforehand prepared to the timing of the MDS and the response data from a mounted vessel will be received (S630), and it will judge whether the received response data are a normal thing corresponding to the transmitted MDS command (S640).

[0073] If response data are normal, it will judge whether a series of communication links according to the sequence set up beforehand were completed (S650) and the communication link will not be completed by reception of the response data, degree sequence is prepared (setup of the MDS command which should be transmitted in S620 etc.) (S660), and this processing is ended. On the other hand, if the communication link is completed, the communication link result which shows that the communication link was completed normally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26 (S670), and this processing will be ended in it.

[0074] When it judged whether the counted value of the count of a retry would be larger than a upper limit if abnormalities are in response data in S640 of the point (S680), and it was below a upper limit and the processing concerned is started next time, a retry setup is carried out so that the same MDS command as what transmitted this time may be transmitted in S620 of the point (S690), and this processing is ended. On the other hand, if the counted value of the count of a retry is larger than a upper limit, the communication link result which shows what the communication link terminated abnormally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26 (S700), and this processing will be ended in it.

[0075] Thus, in the active communications department 22, by assigning MDS to the mounted vessel which answered to the timing of ACTS, and performing a different communication link for every MDS, a broadcast with a maximum of three mounted vessels is possible, and it is made. Next, it explains along with the flow chart which shows actuation of the passive communications department 24 to drawing 9 . In addition, the passive communications department 24 starts like the active communications department 22 according to the command from the timing control section 25.

[0076] If the passive communications department 24 starts like illustration, and it judges whether a setup "under passive communication link" has accomplished (S710) and is not [passive / be / it] "under communication link", [which shows first that it is communicating with the mounted vessel of a passive method] A polling signal is transmitted (S720), and succeedingly, only a predetermined period transmits a subcarrier and receives the response (what modulated the subcarrier with the reply signal showing Car ID) from a mounted vessel (S730).

[0077] At this time, it judges whether it is a normal thing corresponding to a polling signal (S740), and the contents of the received reply signal end this processing as it is, in not being normal. On the other hand, if the contents of the received reply signal are normal, the mount ID shown in the reply signal will be memorized in the predetermined area of the memory which constitutes the data-processing section 26, a setup "under passive communication link" will be performed in it (S750), degree sequence will be prepared for it (setup of the querying signal which should be transmitted in S770

mentioned later) (S760), and this processing will be ended in it.

[0078] If a setup "under passive communication link" is made in S710 of the point, the querying signal currently prepared beforehand is transmitted (S770), and succeedingly, only a predetermined period will transmit a subcarrier and will receive the response (what modulated the subcarrier with the reply signal) from a mounted vessel (S780).

[0079] Judge whether at this time, the contents of the received reply signal are the normal things corresponding to the querying signal transmitted in S770 (S790), and if normal If it judges whether a series of communication links according to the sequence set up beforehand were completed (S800) and the communication link is not completed by reception of the reply signal, the following sequence is prepared (S760) and this processing is ended. On the other hand, if the communication link is completed, the communication link result which shows that the communication link was completed normally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26, a setup "under passive communication link" will be canceled in it (S810), and this processing will be ended in it.

[0080] This processing is ended, after carrying out a retry setup (S830) so that the same querying signal as what transmitted this time may be transmitted in S770 of the point when it judged whether the counted value of the count of a retry would be larger than a upper limit if abnormalities are in the reply signal received in S790 of the point (S820), and it was below a upper limit and the processing concerned is started next time. On the other hand, if the counted value of the count of a retry is larger than a upper limit, the communication link result which shows what the communication link terminated abnormally will be memorized in the predetermined area of the memory which constitutes the data-processing section 26, a setup "under passive communication link" will be canceled in it (S840), and this processing will be ended in it.

[0081] Thus, in the passive communications department 24, any one and the communication link in the mounted vessel which answered the polling signal are made to be performed. Next, the tollgate which has three lanes L1-L3 is made into an example, and the contents of control, the combination of the machines 20a-20c on the street, and the timing 25 of operation, i.e., a timing control section, are explained.

[0082] First, in the tollgate M1 shown in drawing 10 (a), with lanes L1 and L2, common on the street machine 20a is installed in lanes L1 and L2, on-the-street machine only for passive 20c is installed in a lane L3, and the communications area for active methods by the antenna 21 and the communications area for passive methods by the antenna 23 are detached spatially, and moreover, they are set up so that it may not overlap mutually. However, all over drawing, only the antenna is indicated among the configurations of each machine on the street (even the following, drawing 11 , and drawing 12 are the same).

[0083] moreover — common on the street machine 20a of a lane L1 — the object for a passive communication link — a frequency band Fp1 and the object for an active communication link — in common on the street machine 20a of a frequency band Fa2 and a lane L2, a frequency band Fp3 is assigned to a passive communication link a frequency band Fp2 and for an active communication link, and is assigned to the passive communication link in on the street [only for passive] machine 20c of a frequency band Fa1 and a lane L3.

[0084] In addition, one period (henceforth the "active section") of the frame used by the active method and one period (henceforth the "passive section") until it stops sending out of a subcarrier after sending-out initiation of a polling signal or a querying signal by the passive method are set as the same die length.

[0085] And all, the timing control section 25 of each common on-the-street machine 20a of lanes L1 and L2 controls the timing of both the communications departments 22 and 24 of operation to be shown in drawing 10 (b) so that the sending-out timing of a polling signal or a querying signal differs from the sending-out timing of FCM in the same lane.

[0086] Moreover, the timing control section 25 of each machine 20 of lanes L1-L3 on the street controls the timing of each communications departments 22 and 24 of operation so that it interlocks, and the sending-out timing of a polling signal or a querying signal differs mutually with lanes L1 and L3 and a lane L2 and the sending-out timing of FCM differs mutually with a lane L1 and a lane L2.

[0087] In the tollgate M1 constituted as mentioned above, with the lanes L1 and L2 which use common on-the-street machine 20a Since the communications area of an active method and the communications area of a passive method are separated spatially and interference is made not to be caused mutually active and passive — tariff automatic **** the mounted vessel of which communication mode could secure good communication link quality, and did not twist it to the communication mode of a mounted vessel, but it minded the communication link between highway and vehicle can be performed certainly.

[0088] In addition, in the above-mentioned tollgate M1, although what does not overlap mutually the frequency band assigned to the active method and passive method of the same lane is chosen and combined with the lanes L1 and L2 which use

common on-the-street machine 20a, what overlaps mutually may be chosen and combined. That is, when the communications area is separated spatially in this way, the combination of the frequency band of both the communication modes in common on-the-street machine 20a is arbitrary.

[0089] Next, in the tollgate M2 shown in drawing 11 (a), into a lane L1, on the street [only for passive] machine 20c is installed in common on the street machine 20a and a lane L2, on-the-street machine only for active 20b is installed in a lane L3, and moreover, with the lane L1, the communications area for active methods by the antenna 21 and the communications area for passive methods by the antenna 23 are set up so that it may overlap mutually.

[0090] moreover -- common on the street machine 20a of a lane L1 -- the object for a passive communication link -- a frequency band Fa2 is assigned to a passive communication link in on the street [only for passive] machine 20c of a frequency band Fa1 and a lane L2, and is assigned to the frequency band Fp4 and the active communication link for the active communication link by on the street [only for active] machine 20b of a frequency band Fp1 and a lane L3. In addition, the active section and the passive section are set as the same die length like the case of the tollgate M1 explained previously. And to be shown in drawing 11 (b), juxtaposition actuation of both the communications departments 22 and 24 is carried out, and the timing of both the communications departments 22 and 24 of operation is controlled by the timing control section 25 of common on-the-street machine 20a of a lane L1 so that the sending-out timing of a polling signal or a querying signal and the sending-out timing of FCM moreover become simultaneous.

[0091] Moreover, the timing control section 25 of each machine 20 of lanes L1-L3 on the street interlocks, and it is with lanes L1 and L3 and a lane L2, and it controls the timing of each communications departments 22 and 24 of operation so that the sending-out timing of a polling signal or a querying signal differs from the sending-out timing of FCM mutually. active and passive [with the lane L1 which uses common on-the-street machine 20a,] in the tollgate M2 constituted as mentioned above, since the same communications area is used in frequency division by the active method and the passive method and interference is made not to be caused mutually -- tariff automatic **** the mounted vessel of which communication mode could secure good communication link quality, and did not twist it to the communication mode of a mounted vessel, but it minded the communication link between highway and vehicle can perform certainly.

[0092] Moreover, in a tollgate M2, since the same communications area is used by the active method and the passive method, the communications area of both communication modes can make a facility small as compared with the tollgate M1 separated spatially. In addition, in the above-mentioned tollgate M2, although a frequency band Fp4 is used for a passive communication link and the frequency band Fa1 is used for the active communication link in common on the street machine 20a of a lane L1 in which both communication modes are possible When a frequency band Fa1 is used for an active communication link since it is good if frequency bands do not overlap When frequency bands Fp2 and Fp3 may be used for a passive communication link and a frequency band Fa2 is used for an active communication link, frequency bands Fp1 and Fp4 may be used for a passive communication link.

[0093] Next, in the tollgate M3 shown in drawing 12 (a), common on the street machine 20a is installed in lanes L1 and L2, on-the-street machine only for passive 20c is installed in a lane L3, and moreover, with lanes L1 and L2, the communications area for active methods by the antenna 21 and the communications area for passive methods by the antenna 23 are set up so that it may overlap mutually.

[0094] moreover -- common on the street machine 20a of a lane L1 -- the object for a passive communication link -- a frequency band Fp1 and the object for an active communication link -- in common on the street machine 20a of a frequency band Fa2 and a lane L2, a frequency band Fp4 is assigned to a passive communication link a frequency band Fp2 and for an active communication link, and is assigned to the passive communication link in on the street [only for passive] machine 20c of a frequency band Fa1 and a lane L3. In addition, the active section and a passive period are set as the same die length like the case of the tollgate M1 explained previously. And all, the timing control section 25 of each common on-the-street machine 20a of lanes L1 and L2 controls the timing of both the communications departments 22 and 24 of operation to use it, carrying out time sharing of the same communications area to be shown in drawing 12 (b) so that the active section and the passive section appear by turns.

[0095] Moreover, the timing control section 25 of each machine 20 of lanes L1-L3 on the street interlocks, and it is with lanes L1 and L3 and a lane L2, and it controls the timing of each communications departments 22 and 24 of operation so that the sending-out timing of a polling signal or a querying signal differs from the sending-out timing of FCM mutually.

[0096] In the tollgate M3 constituted as mentioned above, with the lanes L1 and L2 which use common on-the-street machine 20a Since the same communications area is used in time sharing by the active method and the passive method and interference

is made not to be caused mutually active and passive — tariff automatic **** the mounted vessel of which communication mode could secure good communication link quality, and did not twist it to the communication mode of a mounted vessel, but it minded the communication link between highway and vehicle can be performed certainly.

[0097] Moreover, in a tollgate M3, since the same communications area is used by the active method and the passive method, the communications area of both communication modes can make a facility small as compared with the tollgate M1 separated spatially. In addition, in the above-mentioned tollgate M3, although what does not overlap mutually the frequency band assigned to the active method and passive method of the same lane is chosen and combined with the lanes L1 and L2 which use common on-the-street machine 20a, what overlaps mutually may be chosen and combined. That is, when using a communications area by time sharing in this way, the combination of the frequency band of both the communication modes in common on-the-street machine 20a is arbitrary.

[0098] Moreover, it is controlling so that the active section and the passive section continue, but the timing control section 25 in each above-mentioned example may be controlled so that the blank section which performs neither of the transmission and reception of the methods is inserted among both [these] the sections. By the way, although actuation of both the communications departments 22 and 24 is changed per the active section and passive section unit, i.e., communication link frame, in common on the street machine 20a in the above-mentioned tollgate M3 As shown in drawing 13 (a), for example, in the active communications department 22 One of MDS with two or more the communication link frames (here MDS0) is made into a disable. In the passive communications department 24 The die length of the passive section may be set as the magnitude settled in one MDS, and you may constitute from a timing control section 25 so that the passive communications department 24 may be operated at the period of this MDS0.

[0099] In addition, the number of MDS assigned in order to operate the passive communications department 24 As two or more pieces are sufficient, for example, it is shown in drawing 13 (b), among MDS (here eight pieces) by which the multi-statement was carried out in the active communications department 22 MDS of the moiety located in the eventh (0, 2, 4, 6) is made usable, and MDS of the remaining moieties located in the oddth (1, 3, 5, 7) is made into a disable. In the timing control section 25 The period of MDS made into this disable may be alike, respectively, and you may constitute so that the passive communications department 24 may be operated.

[0100] Furthermore, the number of MDS assigned in order to operate the passive communications department 24 may be constituted so that an adjustable setup may be carried out according to a communication link condition. In this case, it explains along with the flow chart which shows the MDS allocation processing performed in the data-processing section 26 to drawing 14 . However, actuation of the active communications department 22 and the passive communications department 24 is completely the same as that of what was explained with the flow chart of drawing 7 - drawing 9 .

[0101] When this processing starts like illustration, by the active method the number CA of the mounted vessels under current communication link By the active method smaller (CA<SAmax) than the maximum number SAmax (here 2) in which a broadcast is possible If it judges whether there is empty MDS with possible making the communication link of a new active method start (S910) and there is empty MDS, it will judge whether there are any response data (communication link demand of an active method) of ACTS memorized in S540 of the point (S920).

[0102] If there are response data of ACTS, the communication link demand which newly assigns MDS for a SAmax-CA individual as a limit will be chosen from the inside (S930), and on the other hand, if there are no response data of ACTS, it will judge whether it is that there is a thing under current communication link (CA>=1) (S940). In addition, if selection of a communication link demand is performed in S930, only the part will increase the number CA of the mounted vessels under communication link.

[0103] And since there is a thing under current communication link, or at least one has the communication link of the active method which should assign MDS with the communication link frame transmitted to a degree when it is vacant in S910 of the point, and is judged with there being no MDS or a communication link demand is chosen in S930 of the point, MDS which should be used to these communication links (identified by Car ID) is assigned (S950).

[0104] If allocation of this MDS is completed, or it judges whether "under the passive communication link" is set up as a condition of the passive communications department 24 this time when it is judged with there being nothing under current communication link by the active method in S940 of the point (S960) and "under the passive communication link" is set up, it will judge whether it is that there is empty MDS (CA<SAmax) (S970).

[0105] And when "under the passive communication link" is set up and there is no empty MDS inside, basic allocation which assigns one MDS beforehand secured to the passive communication link is performed (S980), and this processing is ended. On the

other hand, when "under the passive communication link" is set up and there is empty MDS, extended allocation which assigns some of empty MDS (here, let two pieces be an upper limit) to a passive communication link is performed, and this (S990) processing is ended.

[0106] Drawing 15 always secures one MDS to the communication link in a passive method among three MDS which constitutes a communication link frame, and expresses the condition of the communication link frame at the time of setting to 2 (= SAmax) the maximum number of MDS which can be assigned to the communication link in an active method here. When there is no communication link with a passive method or all MDS that can be assigned to a communication link with an active method is assigned to the communication link with an active method by performing the above-mentioned MDS allocation processing, only one MDS is assigned to a passive communication link as shown in (a). Moreover, when MDS which there is a communication link with a passive method, and was assigned to the communication link in an active method is one or less piece, two MDS will be assigned to a passive communication link as shown in (b).

[0107] Since this is used effectively for a communication link with a passive method when [that it is vacant and there is MDS] not used for a communication link with an active method by performing such MDS allocation processing, the throughput of common on-the-street machine 20a can be raised. In addition, when there is no communication link by the active method, you may make it assign all MDS to a communication link with a passive method here, although the maximum number of MDS which can be assigned to a communication link (passive communications department 24) with a passive method was set to 2.

The [3rd operation gestalt], next the 3rd operation gestalt are explained.

[0108] Drawing 16 is a block diagram showing the configuration of the machine on the street formed for every lane of the tollgate of a turnpike in the communication system between road and car of this operation gestalt with which the mounted vessel which performs a communication link between highway and vehicle by the active method, and the mounted vessel which performs a communication link between highway and vehicle by the passive method are intermingled. Like illustration, the machine 30 on the street is equipped with transmitting antenna 31a for passive methods, receiving-antenna 31b, and the transceiver antenna 32 for active methods in this operation gestalt. And the directional coupler 33 which separates the transceiver signal over the transceiver antenna 32, With the common communications department 35 as road-side means of communications which performs the communication link between highway and vehicle with a mounted vessel by sending and receiving a signal through these antennas 31a, 31b, and 32 While supplying the sending signal from the common communications department 35 to either of the transceiver antennas 32 through transmitting antenna 31a or a directional coupler 33 according to the change signal G from the common communications department 35 The antenna change section 34 which supplies either of the input signals from the transceiver antenna 32 through receiving-antenna 31b or a directional coupler 33 to the common communications department 35, It was constituted centering on the well-known microcomputer, and has the data-processing section 36 which performs processing of the data sent and received by the common communications department 35 between mounted vessels etc.

[0109] And in the communication system between road and car of this operation gestalt, it is not concerned with an active and passive communication mode, but the common communication link frame which used the thing of an active method as the base is used for the communication link between highway and vehicle between the machine 30 on the street and a mounted vessel. As this communication link frame is shown in drawing 17 , the following modification is added to FCM, two or more MDS (here four pieces), and the conventional communication link frame that consists of ACTS. That is, by dividing ACTS into a part a part for the first portion, and the second half, receiving the response (communication link demand) from the mounted vessel of an active method in a part for the first portion, and transmitting a subcarrier in a part in the second half, it is possible to receive the response (response of as opposed to [consider that FCM is a polling signal and] the polling) from the mounted vessel of a passive method, and it is made.

[0110] moreover, in MDS which made it possible to assign MDS to both a communication link with an active method, and a communication link with a passive method, and was assigned to the communication link in a passive method By getting down and transmitting a subcarrier during the remaining periods of the MDS after transmission of a command (what communalized the MDS command of an active method, and the querying signal of a passive method), it is possible to receive the response from the mounted vessel of a passive method, and it is made.

[0111] And it communicates by the same approach (only a part for the first portion [However the communication link demand from a mounted vessel] of ACTS use) as usual, and on the other hand, the mounted vessel of a passive method considers that FCM is a polling signal, returns the reply signal over a polling signal in the second half part of ACTS, and communicates with the mounted vessel of an active method

henceforth using assigned MDS.

[0112] In addition, only the period of MDS assigned to the communication link in a passive method and the second half part of ACTS choose the antennas 31a and 31b for passive, and the common communications department 35 consists of other periods so that the antenna 32 for active may be chosen, and the change signal X which operates the antenna change section 34 may be generated.

[0113] Here, it explains along with the flow chart which shows the actuation about transmission and reception of the communication link frame in the common communications department 35 to drawing 18 . However, since the contents only differ from actuation (refer to drawing 7) of the active communications department 22 of the 2nd operation gestalt in part, about the same processing, they attach the same sign, omit explanation and explain it focusing on the part from which processing is different.

[0114] Like illustration, the response from transmission (S510) of FCM, the processing (S520) for every MDS mentioned later, and the mounted vessel of the active method in ACTS timing is processed in the common communications department 35 (S530, S540). However, the data-processing section 26 shall be read as the data-processing section 36 about S510-S540 in the 2nd operation gestalt among explanation, and the active communications department 22 shall read it as the common communications department 35.

[0115] It judges whether succeedingly, only the predetermined period (second half part of ACTS) transmitted the subcarrier (S550), and had the response (what modulated the subcarrier by the response data to polling) from the mounted vessel of a passive method (S560). And if there is no response, this processing will be ended as it is, the response data (car ID) is memorized in the predetermined area of the memory which constitutes the data-processing section 36 when there is a response on the other hand, and this (S670) processing is ended.

[0116] Next, it explains along with the flow chart which shows the detail of the MDS processing in S520 to drawing 19 . This processing shall be repeatedly performed for every timing of each MDS. If this processing is started like illustration, it is based on the response data memorized in S540 and S570 of the point. The condition of MDS set as the object of current processing as a result of the MDS allocation processing which the data-processing section 36 performs active or passive -- if it judges whether it is [slot] "under use" (S610) and is not [slot / be / it] "under use", this processing will be ended as it is. [which was assigned to the communication link with one of methods] On the other hand, to the timing of the MDS, if the condition of the MDS concerned "is slot using it", when [which was set up beforehand] it gets down, a command is transmitted (S620) and the MDS concerned is assigned to the communication link of a passive method (S622-YES), succeedingly, only the remaining periods of the MDS concerned will transmit a subcarrier (S624), and will receive the response data from a mounted vessel (S630).

[0117] Hereafter, processing is performed about the received response data like S640-S700 in the MDS processing explained with the 2nd operation gestalt. However, in S670 and S700, when a passive communication link is completed, a setup "under passive communication link" shall be canceled. Moreover, in a publication with the 2nd operation gestalt, it shall get down from the MDS command and the data-processing section 26 shall be read as a command again at the data-processing section 36.

[0118] In addition, in the above-mentioned processing, S550 and S624 are equivalent to the subcarrier transmitting means in this invention. Next, it explains along with the flow chart which shows the MDS allocation processing which the data-processing section 36 performs to drawing 20 .

[0119] In addition, in MDS allocation processing (refer to drawing 14) in which it explained with the 2nd operation gestalt, in order to enable polling to the mounted vessel of a passive method, at least one MDS is always assigned, but with this operation gestalt, in order to perform processing which is equivalent to polling in FCM and ACTS, it differs in that also in the case of a passive method MDS is assigned only when a communication link is started.

[0120] If this processing is started, and it judges whether a setup "under passive communication link" is made (S900) and is not [passive / be / it] "under communication link", [which shows that the communication link with a mounted vessel is first performed by the passive method like illustration] If it judges whether there is any communication link demand with whether the response data to polling are memorized in S570 of the point and a passive method (S902) and there is a communication link demand with a passive method While choosing from the inside only one thing which starts a communication link, a setup "under passive communication link" is performed (S904).

[0121] And it progresses to degree step, without securing MDS, when it is judged with it passive being "under communication link" in S900, or "under a passive communication link" is newly set up in S904, and MDS of minimum (here one piece) is secured (S906), and it is not, and "it is not passive communicating" on the other hand to the communication link in a passive method and there is also no communication link demand with a passive method in it.

[0122] Hereafter, S910-S950 assign MDS used for a communication link with an active method like explanation with the 2nd operation gestalt. However, in this operation gestalt, if MDS is not secured for the number of maximum MDS which can be assigned to the communication link in an active method for the communication link in a passive method by S906, SAmax is SAmax =4, and if secured, only the part will decrease and it will be set to SAmax =3.

[0123] It judges whether after allocation of MDS for passive methods is completed, "under the passive communication link" is set up (S960), and judges whether if not set up, this processing is ended as it is, there is empty MDS in addition to MDS secured in S906 of the point when set up on the other hand, or there is any total of two or more MDS which is not assigned to active methods (S970). And if there is no empty MDS, basic allocation which assigns one MDS secured to passive methods will be performed (S980), this processing will be ended, extended allocation which also assigns empty MDS to passive methods when there is empty MDS on the other hand will be performed, and this (S990) processing will be ended. By the way, although the mounted vessel of a passive method needs to change processing by having communalized the communication link frame by the active method and the passive method in this way, the processing becomes the almost same thing as the active communications department 22 shown in drawing 3 .

[0124] However, transmission of the response data of S250 and S280 is performed in modulating a subcarrier, and for every assigned MDS, processing of S260-S300 has the need so that it may carry out repeatedly. Thus, S250 and S280 which were improved are equivalent to the 1st response means in this invention, and the 2nd response means, respectively.

[0125] As mentioned above, since according to the communication system between road and car of this operation gestalt the machine 30 on the street cannot be concerned with an active and passive communication mode but can process systematically as explained, it is not necessary to prepare the communications department according to individual for every communication mode, and the configuration of the machine 30 on the street can be simplified.

[0126] In addition, as for the field strength of the electric wave from the mounted vessel which a machine on the street receives, it is desirable to constitute from a passive method in the common communications department 35 so that the amplification factor of the amplifier which amplifies the input signal may be increased, in case a signal is received from receiving-antenna 31b for passive methods since it is a very small thing as compared with the active method. Of course, conversely, in case a signal is received from the transceiver antenna 32 for active methods, you may constitute so that the amplification factor of amplifier may be reduced.

[0127] Moreover, although ACTS is divided into a part a part for the first portion, and the second half, the response of both active and passive communication modes is shifted in time and he is trying to be received with this operation gestalt, as long as the frequency band of an up link of an active method differs from the frequency band which transmits the subcarrier of a passive method, a subcarrier may be sent out over between the whole term of ACTS, and a response may be received to coincidence. However, it is necessary to receive the signal of two kinds of frequency bands to coincidence, and in this case, it is necessary to constitute from a period of ACTS at least so that the signal of those both may be processed.

The [4th operation gestalt] The 4th operation gestalt is explained below.

[0128] Drawing 23 is a block diagram showing the configuration of the mounted vessel which can communicate with any machine on the street in the communication system between road and car with which the machine on the street which offers ETC application by the active method or the passive method, and the machine on the street which offers applications other than ETC by the active method are intermingled.

[0129] In addition, in the communication link between highway and vehicle of an active method and a passive method, it is not based on the class of application but the same communication link frame (refer to drawing 22) as what was explained with the 1st operation gestalt is used. However, an offering-by the communication link between highway and vehicle of active method-ETC application machine on the street As shown in drawing 21 , the object for down links, and the frequency bands Fad1 and Fau1 (it is Fa1 when naming two generically) of the pair for an up link, Or the machine on the street which performs a bidirectional communication link using Fad2 or Fau2 (similarly Fa2), and offers ETC application by the communication link between highway and vehicle of a passive method performs a bidirectional communication link using either of four frequency bands Fp1-Fp4 used bidirectionally.

[0130] Moreover, it is made for the machine on the street which provides the communication link between highway and vehicle of an active method with applications other than ETC to have the bidirectional communication link performed using either of the frequency bands Fedj and Feuj of the object for down links, and the pair for an up link (j=1-5). In addition, the machine on the street which offers applications other than ETC shall be installed in locations which the car has stopped completely or are forced extremely migration at a low speed, such as a parking lot, near the entrance of a public facility, and near the parking location of the car in a

parking lot, near the transit way in a parking lot, and shall offer close leaving management and customer service.

[0131] As shown in drawing 23 , like the mounted vessel 10 of the 1st operation gestalt, the mounted vessel 40 of this operation gestalt was equipped with an antenna 41, the field strength detecting element 42, the active communications department 43, the passive communications department 44, and the data-processing section 45, and is further equipped with the memory 46 which stores the frequency allocation information mentioned later and machine information on the street.

[0132] Among these, the active communications department 43 is not concerned with the object for ETC applications, and applications other than ETC, but it is constituted so that the communication link with a machine on the street may be performed using either of a pair each of frequency bands Fa1, Fa2, Fe1-Fe5 for active methods.

[0133] The passive communications department 44 is constituted by the existence of reception of a communication link frame so that two frequency bands can be judged to coincidence, while any one of the frequency bands Fp1-Fp4 for passive methods is used and a passive method performs the communication link with a machine on the street through an antenna 41. However, with this operation gestalt, only three frequency bands Fp1-Fp3 shall be used among four frequency bands Fp1-F4 for passive methods.

[0134] As shown in drawing 21 , the field strength detecting element 42 is constituted by the frequency bands Fed1-Fed4 used for the communication link of an active method, or the frequency bands B1-B7 which were set up so that it might be in agreement with Fad1, Fed5, and Fad2, respectively so that the field strength may be measured. Therefore, when the field strength of frequency band B5 is measured, the field strength of frequency band B6 is measured relating with frequency bands Fad1 and Fp1 and the field strength of a frequency band B7 is measured relating with frequency bands Fp1 and Fp2, frequency bands Fad2, Fp2, and Fp3 will be related.

[0135] That is, with this operation gestalt, it becomes possible by measuring frequency band B5 and the field strength of B7 to detect the busy condition of all the frequency bands Fad1, Fad2, Fp1-Fp3 for ETC applications. Below, this frequency band B5 and B7 are also called an ETC frequency band.

[0136] The active communications department 43 and the passive communications department 44 match and indicate a communication mode (an active method / passive method), the class (ETC/in addition to this) of application, and a modulation technique (ASK/PSK/QPSK) to be the frequency allocation information memorized by memory 46 for each [which is used for the communication link with a machine on the street] frequency band of every. Moreover, machine information on the street shows using which frequency band the machine on the street which was classified beforehand and which is contained for every area in the area offers application. In addition, an area can set up one area for every machine on the street, or can set up fields where penetration of a car is restricted, such as a highway, as one area.

[0137] The data-processing section 45 is constituted centering on a well-known microcomputer, controls each part 42, 43, and 44 of the above based on the frequency-allocation information and the machine information on the street which were memorized by memory 46 while inputting the positional information which expresses the current position of a car from navigation equipment etc., and the rate information showing the travel speed of ECU which processes the output signal of a speed sensor to a car, and performs processing of the data obtained by the communication link with a machine on the street etc.

[0138] Here, it explains along with the flow chart which shows the Maine processing which the data-processing section 45 performs to drawing 24 . If the frequency scan for specifying the frequency band which the machine on the street is using for offer of service using the field strength detecting element 12 first if this processing starts is performed (S1010) and a frequency is specified with a frequency scan While setting the modulation technique of the active communications department 13 and the passive communications department 14 as the thing corresponding to the specified frequency band based on the frequency allocation information memorized by memory 46 It judges whether it is ETC frequency band B5 and either of B7 which were prepared in order that it might offer ETC application (S1020).

[0139] If the specified frequency is an ETC frequency band, it will judge whether the method currently used for the communication link is an active method in which communications departments 13 and 14 have analyzed the communication link frame from the output of the active communications department 13 and the passive communications department 14 (S1030). And ETC processing with the active method which used the active communications department 13 when the method currently used for the communication link was an active method is performed (S1040), and ETC processing with the passive method which used the passive communications department 14 when return and the method currently used for the communication link were passive methods on the other hand is performed to S1010 (S1050), and it returns to S1010.

[0140] the frequency band specified with a frequency scan in S1020 of the point -- the thing of an ETC frequency band -- **** -- **, when judged The application ID in

a part for the header unit of the frame received through the active communications department 13 is extracted. Judge whether based on this application ID, the application which the machine on the street offers can process with the mounted vessel concerned (S1060), and if processing is not possible Then, on the other hand, if it is return and the thing which can be processed, the application process corresponding to Application ID will be performed to S1010 (S1070), and it will return to it S1010.

[0141] Next, it explains along with the flow chart which shows the detail of the frequency scan performed in S1010 to drawing 25 . Total Umax of the unit unit which acquires the positional information showing the current position of a car (S1110), reads the machine information on the street on an area that it corresponds from memory based on the positional information, and constitutes one period of a change pattern and a change pattern from external navigation equipment etc. first according to the machine information on the street if this processing starts (henceforth "the number of units") It sets up (S1120).

[0142] Here, drawing 26 (a) shows the change pattern set up when judged with measurement being required about all frequency bands from machine information on the street, and is the number Umax of units. It is 15. Whenever it is two unit units and performs ETC frequency band B5 and measurement of B7, it is one unit unit and, specifically, one measurement of the other frequency bands Fed1-Fed5 is performed in order. That is, when the application which a machine on the street offers is ETC application, the frequency band used is specified within 3 unit unit, and it is made for the mounted vessel 40 to have ETC application started.

[0143] Moreover, drawing 26 (b) shows the change pattern set up when judged with it being in the area where any applications other than ETC application are not offered from machine information on the street, and is the number Umax of units. It is 2. Since it is not necessary to measure frequency bands Fed1-Fed5, specifically, only ETC frequency band B5 and measurement of B7 will be repeated and performed.

[0144] And counted value i of the counter for counting the number of units is initialized to 1 (S1130), and the rate information showing the travel speed of a car is acquired from ECU which processes the signal from a speed sensor (S1140). According to this rate information, a unit unit is set [as shown in drawing 26 (c),] up so that a travel speed is early, and a unit unit hour may become short (S1150), and the timer for measuring this unit unit hour is started (S1160).

[0145] Next, based on counted value i, the field strength of the frequency band corresponding to the i-th unit unit in a change pattern is measured (S1170), and it judges whether it is more than the lower limit to which the field strength was set beforehand (S1180). And if field strength is smaller than a lower limit, if the timer started in S1160 of the point has not judged and (S1190) carried out the time-out of whether the time-out was carried out, it will return to S1170, and measurement of field strength will be repeated. On the other hand, if it judges whether it moved beyond predetermined distance (S1200) and is moving beyond predetermined distance from the point of the positional information acquired in S1110 of the point when the timer is carrying out the time-out, it will return to S1110, acquisition of positional information and resetting of a change pattern will be performed, and measurement of field strength will be repeated.

[0146] moreover -- the case where it is not moving beyond predetermined distance -- counted value i of a counter -- incrementing (S1210) -- counted value i -- the number Umax of units of a change pattern a ****** [being large] -- judging (S1220) -- the number Umax of units if large, after initializing counted value i of a counter to 1 (S1230) -- S1140 -- return -- on the other hand -- the number Umax of units the following -- be -- ** -- it remains as it is -- it returns to S1140 without doing anything.

[0147] If it is more than the lower limit to which the field strength obtained by measurement in S1180 of the point was set beforehand, the center frequency of the frequency band corresponding to the i-th unit will be memorized as a detection frequency (S1240), and this processing will be ended. By the way, a unit unit hour is set up as follows. That is, if magnitude of the communications area of V [m/s] and a machine on the street is set to s [m] for the travel speed of a car, a car can express with (1) type the duration tp which passes through a communications area.

[0148]

tp=s/V[s] (1)

Usually, in this duration tp, including a retry, all the amounts of data are set up so that about 3 times of a series of communication links required for offer of application may be possible. It is tp=500[ms] when [in the case of s= 5 [m]] V= 10 [m/s] (= 36 [km/h]). For example, time amount usable for application offer If [it is set to about 170 [ms] (= tp/3) and] V= 30 [m/s] (= 108 [km/h]), it will be tp=167[ms] and time amount usable for application offer will be set to about 50 [ms].

[0149] And a unit unit hour is determined so that one period of a change pattern may consist of a maximum of 15 unit units as mentioned above, and one period of this change pattern may become small enough to the time amount 50-170 usable for application offer [ms]. For example, 1 [ms], then a unit unit hour serve as 1/15 [ms]

extent in one period of a change pattern.

[0150] In addition, in applications other than ETC, since the communication link by super-low ** during a stop is the requisite, since time amount usable for application offer is secured per second, even if it sets up a change pattern and a unit unit hour focusing on ETC application as mentioned above, it can secure sufficient processing time.

[0151] this operation gestalt -- setting -- S1170 -- a rate acquisition means and memory 46 are equivalent to a storage means, and S1120 is [a field strength measurement means, and S1210-S1230 / a frequency change means and S1110] equivalent to a change pattern setting means for a reference-by-location speciality stage and S1140. As explained above, with the mounted vessel of this operation gestalt, the frequency band with which the machine on the street is using the frequency bands B1-B7 set up beforehand for offer of application by carrying out a sequential search according to a change pattern is specified, and moreover, the change pattern is set up so that the frequency of occurrence of an ETC frequency band may become high.

[0152] Therefore, according to the mounted vessel of this operation gestalt, when it not only can cope with various applications, but ETC application is offered from the machine on the street using many frequency bands, it becomes possible to detect this promptly and to start ETC application promptly. Consequently, it performs, while the car is running comparatively at high speed, and even if the time amount permitted by processing is short ** ETC application, the float for communication link retries, as a result communicative dependability are fully securable.

[0153] Moreover, an area be pinpoint based on the positional information which express the location of a car with the mounted vessel of this operation gestalt, and while set up a change pattern only using the frequency band which the machine on the street in the pinpointed area use, based on the rate information showing the travel speed of a car, the unit unit hour which be the measuring time per [which measure each frequency band] time be change so that it may become so short that a travel speed be early.

[0154] Therefore, the frequency band which the machine on the street is using for offer of application can be specified without futility, and even if it is at the high-speed transit time, the processing time for activation of application is fully securable according to the mounted vessel of this operation gestalt.

[0155] In addition, in this operation gestalt, it is constituted so that the field strength of any one frequency band may be measured out of the set-up frequency bands B1-B7, but the field strength detecting element 12 may be constituted so that the field strength of two or more frequency bands can be measured to coincidence. Moreover, although a change pattern is changed or a unit unit hour is changed with this operation gestalt according to rate information according to positional information, either or both of a change pattern or a unit unit hour may be immobilization.

[0156] Furthermore, although ETC application is used with this operation gestalt as specific application with which the frequency of occurrence in the inside of a change pattern increases, the application about the electronic number plate which reads car empty vehicle both the information under transit in addition to this may be used as specific application.

[0157] In addition, as applications other than ETC which a machine on the street offers, a machine on the street may be installed in the parking lot of a department store, the WEB page of the department store may be downloaded on a car, and you may use for the service provision in a counter by telling a customer about sale information, event information, etc. on a department store, or making electronic equipment like PDA or a cellular phone memorize the information further.

[0158] Moreover, a machine on the street is installed in the parking lot of a convenience store, and various money payments enable it to be able to do, without getting down from a car, or you may enable it to receive a music distribution and game distribution within a car. Moreover, usage like a simple message board may be carried out.

[0159] Moreover, a machine on the street may be installed in a parking lot outlet, and you may make it the car which runs near an outlet to tell recession of the car from a parking lot etc. Moreover, you may make it offer real time traffic information and the information (for example, crossing name etc.) for getting to know the current position in various locations with the machine on the street installed near the road.

[0160] Furthermore, it may apply to train traffic control systems, such as a bus, and a taxi or a transportation truck, and you may constitute so that the communication link with the mounted vessel and the machine on the street which were carried by each car may perform transfer of grasp of the operation situation of each car, or an allocation-of-cars situation, the accident information on each car, etc.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a block diagram showing the outline configuration of the mounted vessel in the communication system between road and car of the 1st operation gestalt.

[Drawing 2] It is a flow chart showing the contents of the Maine processing which the data-processing section performs.

[Drawing 3] It is a flow chart showing the activity of the active communications department.

[Drawing 4] It is a flow chart showing the activity of the passive communications department.

[Drawing 5] It is a flow chart showing the contents of the Maine processing of a modification.

[Drawing 6] It is a block diagram showing the outline configuration of the machine on the street in the communication system between road and car of the 2nd operation gestalt.

[Drawing 7] It is a flow chart showing the activity of the active communications department.

[Drawing 8] It is a flow chart showing the detailed contents of MDS processing.

[Drawing 9] It is a flow chart showing the activity of the passive communications department.

[Drawing 10] It is an explanatory view showing the control approach in the example of a configuration and timing control section of a tollgate.

[Drawing 11] It is an explanatory view showing the control approach in the example of a configuration and timing control section of a tollgate.

[Drawing 12] It is an explanatory view showing the control approach in the example of a configuration and timing control section of a tollgate.

[Drawing 13] It is an explanatory view showing the control approach in a timing control section.

[Drawing 14] It is a flow chart showing the contents of the MDS allocation processing which the data-processing section performs.

[Drawing 15] It is an explanatory view showing the control state based on MDS allocation processing.

[Drawing 16] It is a block diagram showing the outline configuration of the machine on the street in the communication system between road and car of the 3rd operation gestalt.

[Drawing 17] It is an explanatory view showing the configuration of the communication link frame used with a communication system between road and car, and actuation of the antenna change section.

[Drawing 18] It is a flow chart showing the activity of the common communications department.

[Drawing 19] It is a flow chart showing the detailed contents of MDS processing.

[Drawing 20] It is a flow chart showing the contents of the MDS allocation processing which the data-processing section performs.

[Drawing 21] It is an explanatory view showing distribution of the frequency band used for a communication link in DSRC.

[Drawing 22] It is an explanatory view showing the configuration of the communication link frame in a conventional passive method and a conventional active method.

[Drawing 23] It is a block diagram showing the outline configuration of the mounted vessel in the communication system between road and car of the 4th operation gestalt.

[Drawing 24] It is a flow chart showing the contents of the Maine processing which the data-processing section performs.

[Drawing 25] It is a flow chart showing the detail of the frequency scan performed in the Maine processing.

[Drawing 26] It is an explanatory view showing the change pattern of the test-frequency band at the time of field strength measurement.

[Description of Notations]

10 40 — 11 A mounted vessel, 41 — 12 An antenna, 42 — Field strength detecting element, 13 43 — 14 The active communications department, 44 — 15 The passive communications department, 45 — Data-processing section, 46 [— A machine on the street / only for active /,] — 20 Memory, 30 — A machine on the street, 20a —

A common machine on the street, 20b 20c -- A machine on the street [only for passive], 21, 23, 31a, 31b, 32 -- Antenna, 22 [-- The data-processing section, 33 / -- A directional coupler, 34 / -- The antenna change section, 35 / -- The common communications department, L1, L2, L3 / -- A lane, M1 M2, M3 / -- Tollgate.] -- The active communications department, 24 -- The passive communications department, 25 -- 26 A timing control section, 36

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

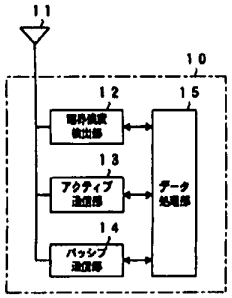
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

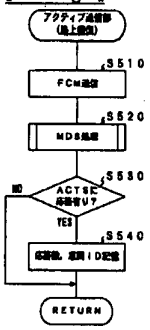
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 7]



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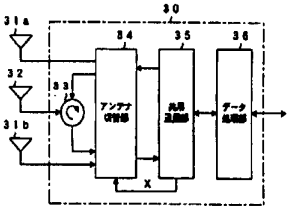

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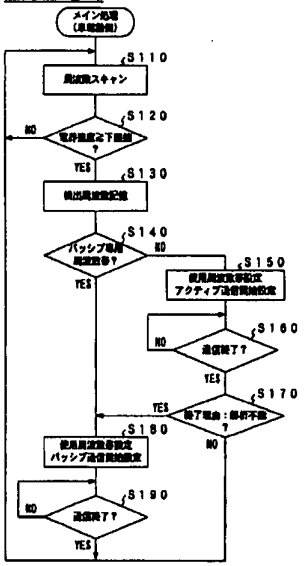

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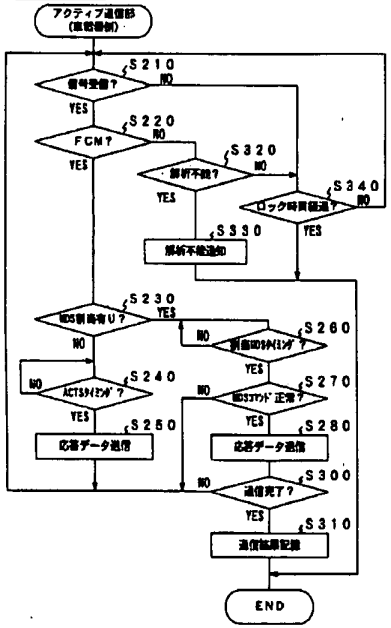

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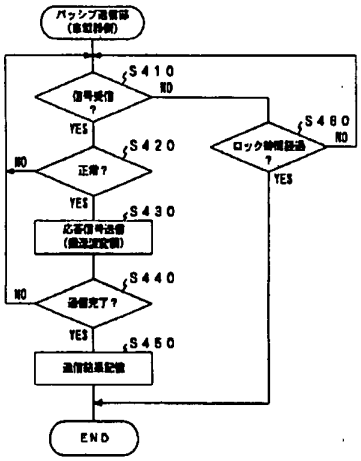

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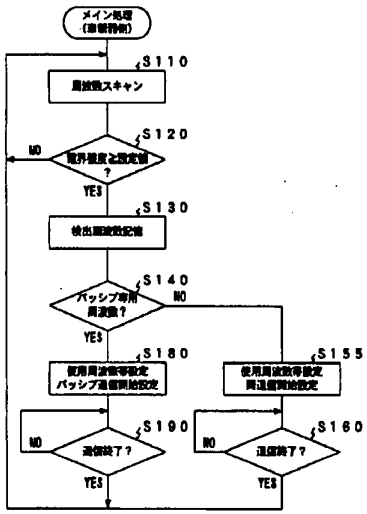

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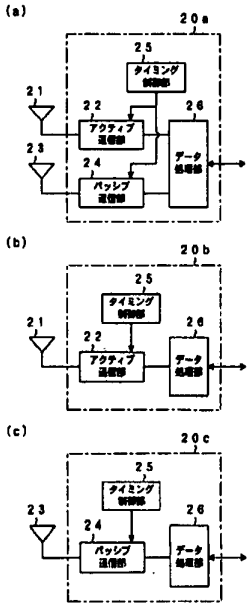

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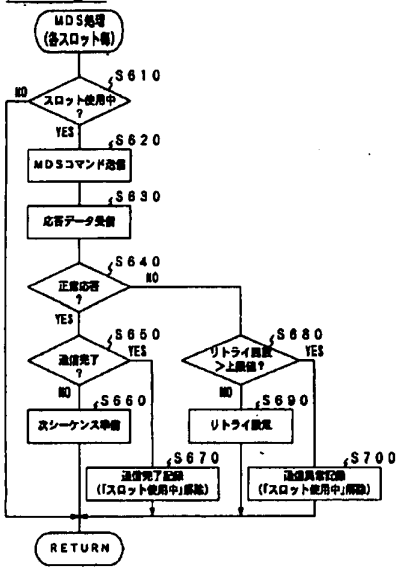

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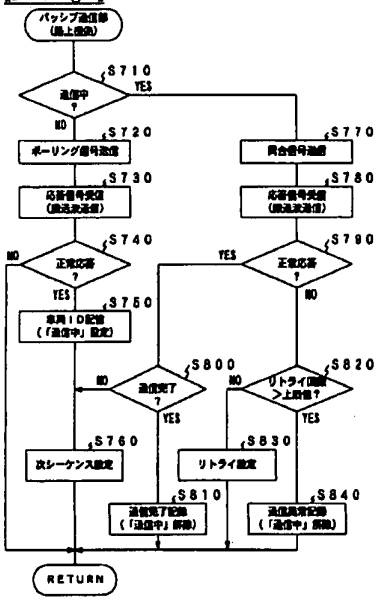

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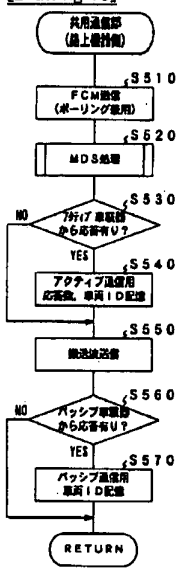

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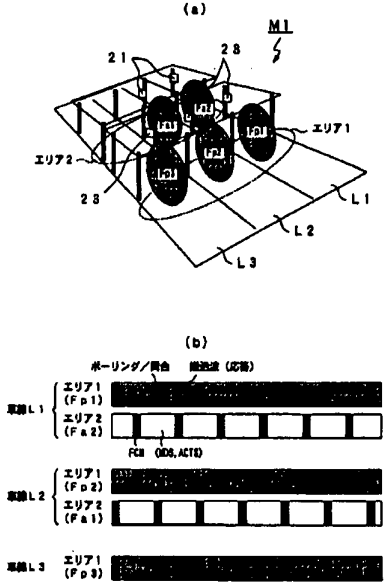

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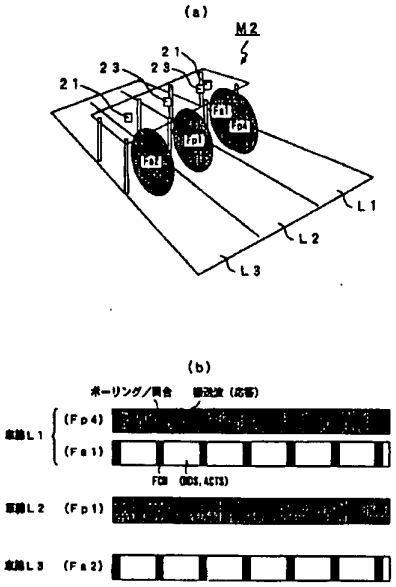

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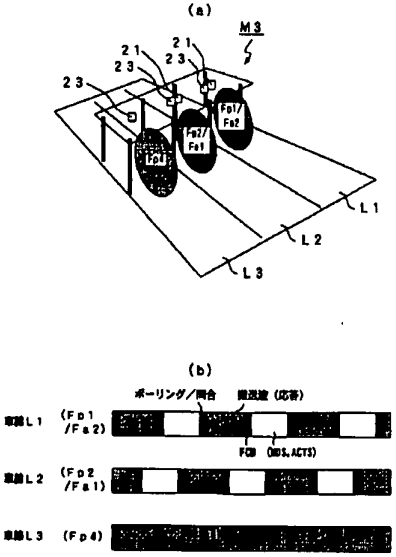

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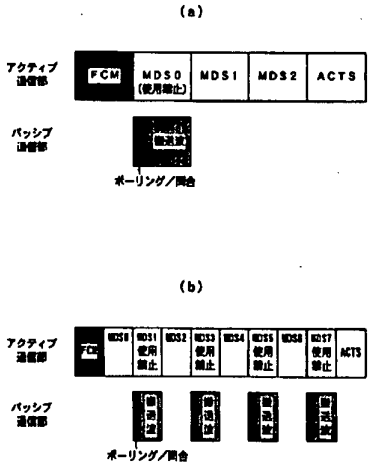

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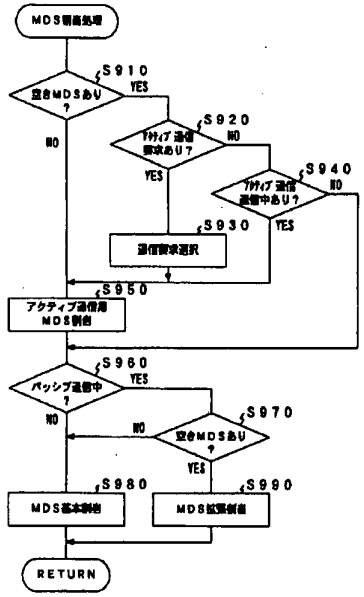

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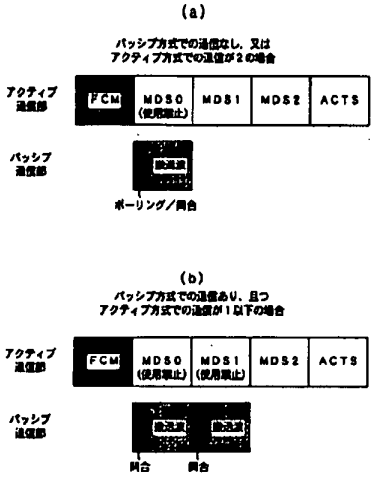

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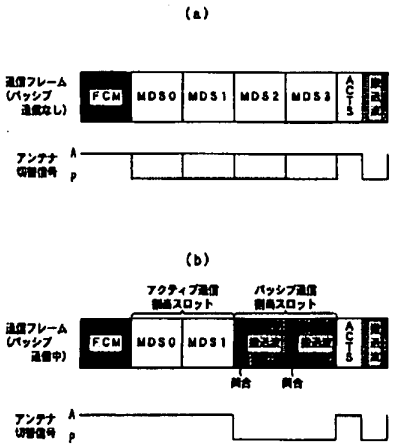
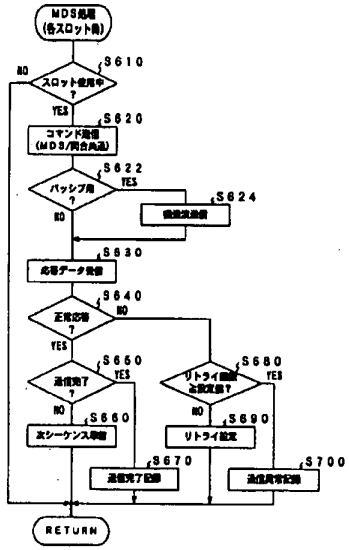


[Drawing 19]



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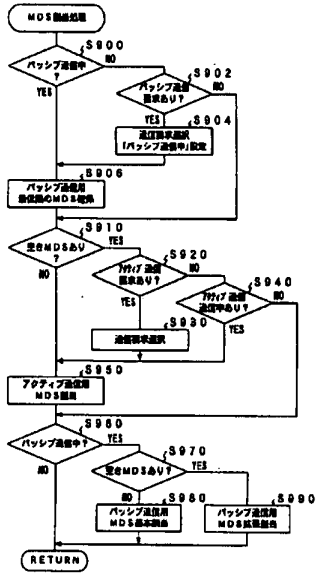

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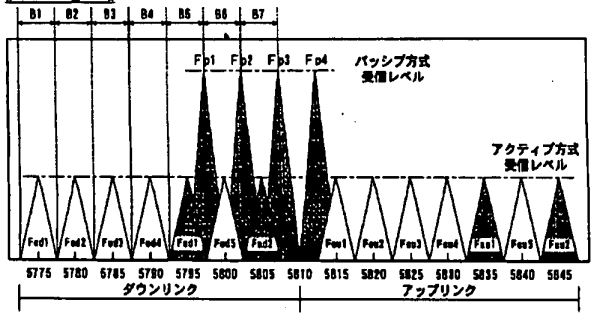
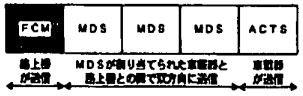
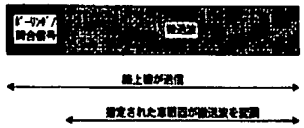


[Drawing 22]

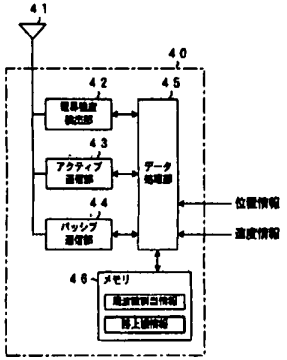
(a)



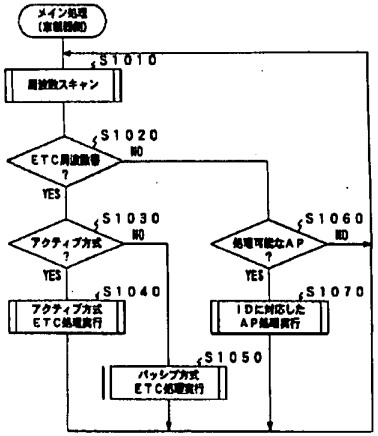
(b)



[Drawing 23]



[Drawing 24]



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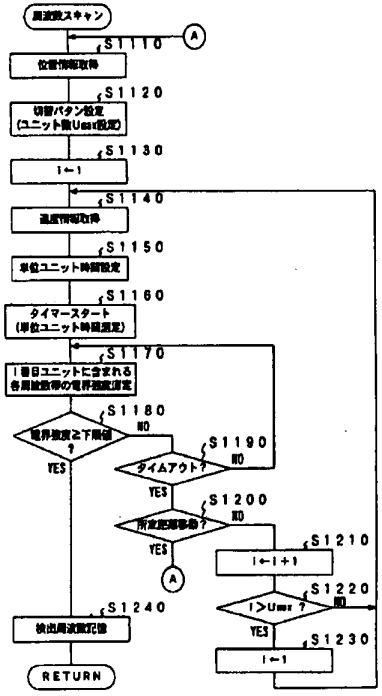
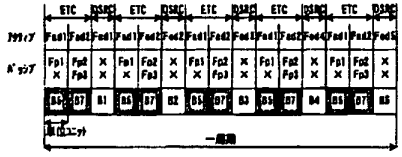
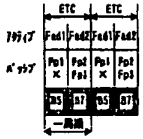


[Drawing 26]

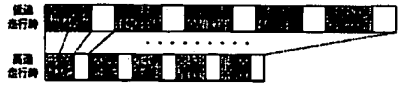
(a)



(b)



(c)



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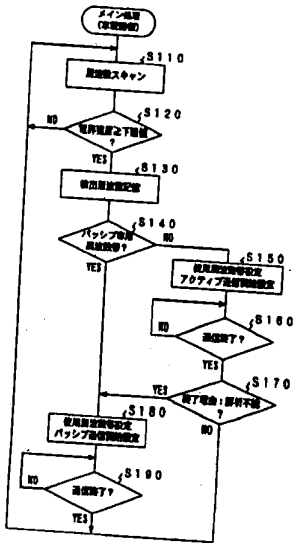
最終頁に続く

(54)【発明の名称】　路車間通信システム，車載器，路上機

(57)【要約】
【課題】　路車間通信で用いられる二つの方式（アクティブ，パッシブ）のいずれにも対処可能な車載器，路上機，及び路車間通信システムを提供する。
【解決手段】　車載器は，アクティブ方式のダウンリンク，及びパッシブ方式に用いる周波数帯をスキャンし，受信電波の電界強度が予め設定された下限値以上である場合，路上機の通信エリアに進入したものとして，その周波数を記憶する（S110～S130）。記憶した周波数が，パッシブ方式に専用の周波数帯に属していれば，直ちにパッシブ通信部を起動して，パッシブ方式による通信を開始する。一方，記憶した周波数が両方式で共用される周波数帯に属している場合には，まず，アクティブ通信部を起動してアクティブ方式での通信を試み，受信した信号の内容を解析できない場合には，パッシブ通信部を起動してパッシブ方式での通信に切り替える（S140～S190）。



【特許請求の範囲】
【請求項１】　車両の走行経路の近傍に設置された路上機との通信のために車両に搭載される路車間通信用の車載器であって，
受信した下り信号とは異なる周波数帯を用いて上り信号を自律的に送信するアクティブ方式により路上機との通信を行う第１車側通信手段と，
受信した質問信号に対し，該質問信号に続いて受信する無変調の搬送波を応答信号にて変調し返送することで応答するパッシブ方式により路上機との通信を行う第２車側通信手段と，
前記路上機の通信エリアに進入すると，前記第１或いは第２車側通信手段のいずれか一方を動作させ，通信不能であれば他方に切り替える車側切替制御手段と，
を備えることを特徴とする車載器。
【請求項２】　前記路上機から受信した信号の周波数帯を識別する周波数識別手段を設け，
前記車側切替制御手段は，前記周波数識別手段にて識別された周波数帯が，前記アクティブ方式或いはパッシブ方式のいずれかの通信方式に専用の周波数帯である場合，該通信方式に対応する車側通信手段を直ちに動作させることを特徴とする請求項１記載の車載器。
【請求項３】　車両の走行経路の近傍に設置された路上機との通信を行うために車両に搭載される路車間通信用の車載器であって，
受信した下り信号とは異なる周波数帯を用いて上り信号を自律的に送信するアクティブ方式により路上機との通信を行う第１車側通信手段と，
受信した質問信号に対し，該質問信号に続いて受信する無変調の搬送波を応答信号にて変調し返送することで応答するパッシブ方式により路上機との通信を行う第２車側通信手段と，
前記路上機の通信エリアに進入すると，前記第１及び第２車側通信手段を並列動作させ，正常な出力が得られた側を継続して動作させる選択制御手段と，
を備えることを特徴とする車載器。
【請求項４】　受信した下り信号とは異なる周波数帯を用いて上り信号を自律的に送信するアクティブ方式の車載器，及び受信した質問信号に対し，該質問信号に続いて受信する無変調の搬送波を応答信号にて変調し返送することで応答するパッシブ方式の車載器のいずれとも通信が可能な路車間通信用の路上機であって，
前記アクティブ方式の車載器との通信を行う第１路側通信手段と，
前パッシブ方式の車載器との通信を行う第２路側通信手段と，を備え，前記第１及び第２路側通信手段を，それぞれの通信エリアが車両の走行経路に沿って且つ互いに重なり合うことなく配置されるよう設定したことを特徴とする路上機。
【請求項５】　受信した下り信号とは異なる周波数帯を用いて上り信号を自律的に送信するアクティブ方式の車載器，及び受信した質問信号に対し，該質問信号に続いて受信する無変調の搬送波を応答信号にて変調し返送することで応答するパッシブ方式の車載器のいずれとも通信が可能な路車間通信用の路上機であって，
前記アクティブ方式の車載器との通信を行う第１路側通信手段と，
該第１路側通信手段と通信エリアが一致するよう設定され，前記パッシブ方式の車載器との通信を行う第２路側通信手段と，
を備え，前記第１及び第２路側通信手段を，それぞれの通信に用いる周波数帯が互いに異なるように設定したことを特徴とする路上機。
【請求項６】　受信した下り信号とは異なる周波数帯を用いて上り信号を自律的に送信するアクティブ方式の車載器，及び受信した質問信号に対し，該質問信号に続いて受信する無変調の搬送波を応答信号にて変調し返送することで応答するパッシブ方式の車載器のいずれとも通信が可能な路車間通信用の路上機であって，
前記アクティブ方式の車載器との通信を行う第１路側通信手段と，
該第１路側通信手段と通信エリアが一致するよう設定され，前記パッシブ方式の車載器との通信を行う第２路側通信手段と，
予め設定されたタイミングに従って，前記第１或いは第２路側通信手段のいずれかを択一的に動作させる路側切替制御手段と，
を備えることを特徴とする路上機。
【請求項７】　請求項６記載の路上機において，
前記第１路側通信手段は，複数の車載器との同時通信が可能なようにデータ用スロットを複数設けた通信フレームを使用し，
前記路側切替制御手段は，前記第１路側通信手段による使用が禁止されたデータ用スロットを少なくとも一つ設定し，該データ用スロットの期間に前記第１路側通信手段を動作させることを特徴とする路上機。
【請求項８】　前記路側切替制御手段は，前記データ用スロットに空きがある場合，該スロット期間でも前記第２路側通信手段を動作させることを特徴とする請求項７記載の路上機。
【請求項９】　路上機から受信した下り信号とは異なる周波数帯を用いて，路上機への上り信号を車載器が自律的に送信するアクティブ方式と，路上機から受信した質問信号に対して車載器は該質問信号に続いて送信されてくる無変調の搬送波を応答信号にて変調し返送することで応答するパッシブ方式とが混在する路車間通信システムであって，
路車間通信用の通信フレームとして，車載器が路上機に対する通信要求を書き込むための上り制御用スロット，通信が許可された車載器に対して割り当てられる

データ用スロット、該データ用スロット及び前記上り制御用スロットより先に送出され、路上機が車載器に対して前記データ用スロットの割当状態を通知するための下り制御用スロットからなるアクティブ方式用のものを使用し、

路上機は、前記上り制御用スロットの期間、及びパッシブ方式の車載器に割り当てられたデータ用スロット内の下り信号に続く期間に無変調の搬送波を送信し、該搬送波を変調することでパッシブ方式の車載器から返送されてくる応答信号を、アクティブ方式の車載器からの上り信号と同等のものとして処理すると共に、

パッシブ方式の車載器は、前記下り制御用スロットをポーリング信号とみなして、前記上り制御用スロットの期間に送信されてくる無変調の搬送波をポーリング信号に対する応答信号にて変調し返送すると共に、前記下り制御用スロットに当該車載器に対するデータ用スロットの割当が示されている場合、該割り当てられたデータ用スロットの期間に受信する下り信号を問合信号とし、該下り信号に引き続いて送信されてくる無変調の搬送波を、問合信号に対する応答信号にて変調し返送することを特徴とする路車間通信システム。

【請求項１０】 請求項９記載の路車間通信システムにて使用される路上機であって、

前記下り制御用スロット，データ用スロット，上り制御用スロットからなる通信フレームを用いてアクティブ方式にて車載器との通信を行う路側通信手段と、

前記上り制御用スロットの期間、及びパッシブ方式の車載器に割り当てられたデータ用スロット内の下り信号に続く期間に無変調の搬送波を送信する搬送波送信手段と、

を備え、前記路側通信手段は、前記搬送波を変調することでパッシブ方式の車載器から返送されてくる応答信号を、アクティブ方式の車載器からの上り信号と同等のものとして処理することを特徴とする路上機，

【請求項１１】 請求項９記載の路車間通信システムにて使用されるパッシブ方式の車載器であって、

路上機の通信エリアに進入すると、前記下り制御用スロットをポーリング信号とみなして、前記上り制御用スロットの期間に送信されてくる無変調の搬送波を、ポーリング信号に対する応答信号にて変調し返送する第１応答手段と、

前記下り制御用スロットにて当該車載器に対するデータ用スロットの割当が示されている場合、該割り当てられたデータ用スロットの期間に受信する下り信号を問合信号とし、該下り信号に引き続いて送信されてくる無変調の搬送波を、問合信号に対する応答信号にて変調し返送する第２応答手段と、

を備えることを特徴とする車載器。

【請求項１２】 車両の走行経路の近傍に設置された路上機との通信のために車両に搭載され、前記路上機から

受信した信号の周波数帯を識別する周波数識別手段を備えた路車間通信用の車載器において、

前記周波数識別手段は、

設定された周波数帯の電界強度を測定する電界強度測定手段と、

該電界強度測定手段での測定対象となる周波数帯を予め設定された切替パタンに従って順次切り替える周波数切替手段と、

を備え、前記切替パタンは、限定された時間内に処理を完結させなければならない特定アプリケーション用に割り当てられた周波数帯の出現頻度が高くなるよう設定されていることを特徴とする車載器。

【請求項１３】 車両の走行速度を取得する速度取得手段を設け、

前記周波数切替手段は、

設定された単位ユニット時間毎に測定対象となる周波数帯を切り替えると共に、前記速度取得手段にて取得される走行速度が早いほど、前記単位ユニット時間が短くなるよう該単位ユニット時間を変化させることを特徴とする請求項１２記載の車載器。

【請求項１４】 車両の現在位置を取得する位置取得手段と、

予め区分けされた区域毎に、各区域内に設置された路上機が使用する周波数帯に関する情報を少なくとも含む路上機情報を記憶する記憶手段と、

該記憶手段に記憶された路上機情報に基づき、前記位置取得手段にて取得した現在位置から、前記周波数識別手段での探索対象となる周波数帯を絞り込んで、前記切替パタンを設定する切替パタン設定手段と、

を設けたことを特徴とする請求項１２又は請求項１３記載の車載器。

【請求項１５】 前記特定アプリケーションは、自動料金収受システム（ＥＴＣ）に関する処理であることを特徴とする請求項１２乃至請求項１４いずれか記載の車載器。

【請求項１６】 前記特定アプリケーションは、電子ナンバープレートに関する処理であることを特徴とする請求項１２乃至請求項１４いずれか記載の車載器。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、路車間通信に使用されている二つの方式（パッシブ，アクティブ）が混在する路車間通信システム、及び両方式や路車間通信を介した種々のアプリケーションに対応可能な車載器，路上機に関する。

【０００２】

【従来の技術】従来より、車両に搭載された車載器、及び車両の走行路近傍に設置された路上機との間で双方向通信を行うことにより、有料道路における料金自動収受（ＥＴＣ）等を実現するための通信方式として、ＤＳＲＣ（Dedicated Short Range Communication）が知られている。この通信方式には二つの方式、即ち、車載器から路上機への上り信号の送信を、路上機から車載器への下り信号に続けて送信されてくる搬送波を変調して返送することにより行うパッシブ方式（ヨーロッパ，中国，東南アジアで採用）と、上り信号の送信を、下り信号とは異なる周波数帯を用いて車載器が自律的に行うアクティブ方式（日本で採用）とが存在している。

【０００３】このため将来的には、道路が続いていても、政治的な管轄や法律が変わる境界（国境など）にて、ＥＴＣに使用されている通信方式がパッシブ方式からアクティブ方式（又はその逆）に変わってしまったり、上記境界を挟んだ地域では、両方式の路上機が混在して配置されることが考えられる。

【０００４】

【発明が解決しようとする課題】そして、前者の場合、いずれか一方の方式に対応した車載器しか搭載していない車両では、車両を停止することなく料金収受を行えるという利便性が、上記境界を越えることによって損なわれてしまうだけでなく、通信方式の異なる路上機とは通信ができないため、このような路上機によって違反車両として取り扱われてしまう可能性があるという問題があった。

【０００５】また、後者の場合、アクティブ方式とパッシブ方式とでは、使用する周波数帯の一部が互いに重なり合っているため、干渉が生じて通信品質が劣化し、通信不能となるおそれがあるという問題があった。即ち、図２１に斜線にて示すように、アクティブ方式には、５７９５ＭＨｚ，５８０５ＭＨｚ，５８３５ＭＨｚ，５８４５ＭＨｚを中心周波数とする帯域幅が５ＭＨｚの四つの周波数帯Ｆａｄ１，Ｆａｄ２，Ｆａｕ１，Ｆａｕ２が、路上器から車載器への下り信号用（Ｆａｄ１，Ｆａｄ２）、及び車載器から路上機への上り信号用（Ｆａｕ１，Ｆａｕ２）に、それぞれ二つずつ割り当てられ、一方、パッシブ方式には、５７９７．５ＭＨｚ，５８０２．５ＭＨｚ，５８０７．５ＭＨｚ，５８１２．５ＭＨｚを中心周波数とする帯域幅が５ＭＨｚの四つの周波数帯Ｆｐ１～Ｆｐ４が、いずれも双方向の通信用に割り当てられている。従って、アクティブ方式のＦａｄ１はパッシブ方式のＦｐ１と、アクティブ方式のＦａｄ２はパッシブ方式のＦｐ２，Ｆｐ３と干渉を起こす可能性があるのである。

【０００６】ところで、近年では５．８ＧＨｚ帯の通信周波数帯域でＥＴＣに使用されていない周波数帯域を用いて、ＤＳＲＣ通信を利用した新規なアプリケーションを提供することが考えられている。この場合、図２１に示すように、既存のＥＴＣのアクティブ方式とは異なった周波数帯、５７７５ＭＨｚ，５７８０ＭＨｚ，５７８５ＭＨｚ，５７９０ＭＨｚ，５８００ＭＨｚ，５８１５ＭＨｚ，５８２０ＭＨｚ，５８２５ＭＨｚ，５８３０ＭＨｚ，５８４０ＭＨｚをそれぞれ中心周波数とする帯域

幅が５ＭＨｚの１０個の周波数帯Ｆｅｄ１～Ｆｅｄ５（路上器から車載器への下り信号用），Ｆｅｕ１～Ｆｅｕ５（車載器から路上機への上り信号用）を用いることが予定されている。

【０００７】従って、今後、車載器は、既存のＥＴＣだけでなく、これら新規のアプリケーションにも対応できるように構成することが要求される。つまり、車載器は、アクティブ方式とパッシブ方式とを識別する機能だけでなく、受信した電波の周波数帯に基づいて実行するアプリケーションを選択する機能が必要となる。

【０００８】特に、ＥＴＣでは、システムの信頼性を確保するため、通信に失敗したときに通信のリトライが可能となるようにシステムを設計することで、通信に失敗したまま車両が通信エリアを通過してしまう確率が十分に小さくなる（例えば１００万台に１台以下）ようにしている。

【０００９】具体的には、車両が設定車両速度（想定最高速度）で通信エリアを通過する時間を、使用周波数帯が特定されてからＥＴＣ処理（認証やカードへの書込など）が完了するまでに要する時間の３倍程度に設定し、充分な余裕時間を確保している。

【００１０】しかし、ＥＴＣアプリケーションと新規のアプリケーションとのいずれにも対応可能な車載器では、ＥＴＣアプリケーションのみを実行するものと比較して、余分に５つもの周波数帯を探索しなければならず、使用周波数帯の特定に時間がかかり、その結果、通信リトライ用の余裕時間が削られてしまい、通信の信頼性を低下させてしまうという問題があった。

【００１１】本発明は、上記問題点を解決するために、路車間通信で用いられる二つの方式（アクティブ，パッシブ）のいずれにも対処可能な車載器，路上機、及び路車間通信システムを提供することを第１の目的とし、更に、限定された時間内で処理を完結させなければならないＥＴＣ等の特定アプリケーションの信頼性を低下させることなく、多様なアプリケーションに対処可能な車載器を提供することを第２の目的とする。

【００１２】

【課題を解決するための手段】上記目的を達成するための発明である請求項１記載の車載器では、第１車側通信手段が、受信した下り信号とは異なる周波数帯を用いて上り信号を自律的に送信するアクティブ方式により路上機との通信を行い、第２車側通信手段が、受信した質問信号に対し、該質問信号に続いて受信する無変調の搬送波を応答信号にて変調し返送することで応答するパッシブ方式により路上機との通信を行う。

【００１３】そして、路上機の通信エリアに進入すると、車側切替制御手段が、第１或いは第２車側通信手段のいずれか一方を動作させ、通信不能であれば他方に切り替えることにより、通信可能な車側通信手段をサーチする。従って、本発明の車載器によれば、路上機がアク

ティブ方式或いはパッシブ方式のいずれか一方に対応した専用の機種であったとしても、これと確実に通信することができる。

【0014】なお、アクティブ方式とパッシブ方式とで、使用する周波数帯の中に他方との共用とはならない専用の周波数帯が存在する場合には、請求項2記載のように、周波数識別手段にて、路上機から送信される信号の周波数帯を識別し、車側切替制御手段は、その識別された周波数帯が、いずれかの通信方式に専用の周波数帯であれば、その通信方式に対応する車側通信手段を直ちに動作させるようにしてもよい。

【0015】この場合、周波数識別手段にて識別された周波数帯が、両通信方式が共用するものである時にのみ、第1及び第2車側通信手段のうちいずれが通信可能であるかを特定するためのサーチが行われることになるため、通信開始までの平均時間を短縮することができる。

【0016】次に請求項3記載の車載器では、路上機の通信エリアに進入すると、車側選択制御手段が、第1及び第2車側通信手段を並列動作させ、正常な出力が得られた側を継続して動作させる。従って、本発明の車載器によれば、路上機がアクティブ方式及びパッシブ方式のいずれか一方のみに対応した専用の機種であったとしても、これと確実に通信することができ、しかも必要最小限の時間で、路上機との通信を開始させることができる。

【0017】ここまでは、いずれの通信方式にも対処できるように構成した車載器について説明したが、以下では、いずれの通信方式にも対処できるように構成した路上機について説明する。まず、請求項4記載の路上機では、アクティブ方式の車載器との通信を行う第1路側通信手段と、パッシブ方式の車載器との通信を行う第2路側通信手段とを備え、これら第1及び第2路側通信手段を、それぞれの通信エリアが車両の走行経路に沿って且つ互いに重なり合うことなく配置されるよう設定している。従って、走行経路に沿って走行する車両は、第1及び第2路側通信手段の各通信エリアをいずれも通過することになる。

【0018】このように、本発明の路上機によれば、両通信方式の通信エリアが空間的に分離されているため、両通信方式で同じ周波数帯が用いられていたとしても、両通信方式の信号が干渉を起こすことがなく、いずれの通信方式の車載器に対しても良好な通信品質が確保される。その結果、車両に搭載された車載器が、いずれか一方の通信方式に専用のものであったとしても、これと確実に通信することができる。

【0019】次に請求項5記載の路上機では、第1及び第2路側通信手段を、それぞれの通信エリアが一致し、しかも、それぞれの通信に用いる周波数帯が互いに異なるように設定している。このように、本発明の路上機によれば、両通信方式の信号が周波数的に分離されているため、両通信方式の通信エリアが同じであっても、両通信方式の信号が干渉を起こすことがなく、いずれの通信方式の車載器に対しても良好な通信品質が確保される。その結果、車両に搭載された車載器が、いずれか一方の通信方式に専用のものであったとしても、これと確実に通信することができる。

【0020】また次に請求項6記載の路上機では、第1及び第2路側通信手段を、それぞれの通信エリアが一致するように設定し、路側切替制御手段が、予め設定されたタイミングに従って、第1或いは第2路側通信手段のいずれかを択一的に動作させている。

【0021】このように、本発明の路上機によれば、両通信方式の信号が時間的に分離されているため、両通信方式の通信エリアが同じであっても、両通信方式の信号が干渉を起こすことがなく、いずれの通信方式の車載器であっても良好な通信品質が確保される。その結果、車両に搭載された車載器が、いずれか一方の通信方式に専用のものであったとしても、これと確実に通信することができる。

【0022】なお、路側切替制御手段が、動作させる路側通信手段（即ち通信方式）を切り替えるタイミングとしては、それぞれが用いる通信フレームの単位で切り替えるようにしてもよいが、例えば、請求項7記載のように、アクティブ方式の通信フレームとして、複数の車載器との同時通信が可能なようにデータ用スロットを複数設けたものが用いられている場合には、第1路側通信手段による使用が禁止されたデータ用スロットを少なくとも一つ設定し、そのデータ用スロットの期間に第2路側通信手段を動作させるようにしてもよい。

【0023】更に、路側切替制御手段は、請求項8記載のように、路上機との通信を必要とするアクティブ方式の車載器が、アクティブ方式用に確保されたデータ用スロットの数より少なく、データ用スロットに空きがある場合、該スロット期間でも第2路側通信手段を動作させるようにしてもよい。

【0024】この場合、データ用スロットが効率よく使用され、1度に1つの車載器としか通信できないパッシブ方式での通信を、短時間で終了させることができ、処理能力を向上させることができる。ところで、上述の方法では、いずれかがアクティブ，パッシブ両方式の通信手段を持ち、これを切り替えて使用しているため、それぞれの通信方式の手順に変更を加える必要がなく従来装置を利用して簡単に構成できるが、装置が大型化してしまうことが予想される。

【0025】この問題を解決するため、請求項9記載の路車間通信システムでは、図22に示すように、車間通信用の通信フレームとして、車載器が路上機に対する通信要求を書き込むための上り制御用スロット（ACTSに対応）、この上り制御用スロットに書き込まれた通信要求に基づき、通信を許可する車載器に対して割り当てられる複数のデータ用スロット（MDSに対応）、データ用スロット及び上り制御用スロットより先に送出され、データ用スロットの割当状態を路上機が車載器に対して通知するための下り制御用スロット（FCMに対応）からなるアクティブ方式用のものを使用し、この通信フレームを用いてパッシブ方式での通信も可能となるように、路上機及びパッシブ方式の車載器を以下のように構成する。

【0026】即ち、路上機は、上り制御用スロットの期間、及びパッシブ方式の車載器に割り当てられたデータ用スロット内の下り信号に続く期間に無変調の搬送波を送信し、この搬送波を変調することでパッシブ方式の車載器から返送されてくる応答信号を、アクティブ方式の車載器からの上り信号と同等のものとして処理する。

【0027】一方、パッシブ方式の車載器は、下り制御用スロットをポーリング信号とみなして、上り制御用スロットの期間に送信されてくる無変調の搬送波をポーリング信号に対する応答信号にて変調し返送すると共に、下り制御用スロットに当該車載器に対するデータ用スロットの割当が示されている場合、該割り当てられたデータ用スロットの期間に受信する下り信号を問合信号とし、該下り信号に引き続いて送信されてくる無変調の搬送波を、問合信号に対する応答信号にて変調し返送する。

【0028】このように、本発明の路車間通信システムによれば、パッシブ方式の処理を一部変更して、アクティブ方式の処理と共通の通信フレームを用いて処理できるようにされており、両通信方式の車載器との通信を共通に処理することが可能なため、両通信方式の車載器に対処可能な路上機の構成を大幅に簡易化できる。

【0029】また、アクティブ方式の上り／下り信号、パッシブ方式の問合／応答信号に用いるコマンド、及びこれらのコマンドを用いた通信手順も共通化すれば、これらの信号に対する処理も、アクティブ，パッシブの違いを意識することなく行うことができる。

【0030】なお、請求項9記載の路車間通信システムにおいて、路側器は、例えば請求項10記載のように、下り制御用スロット，データ用スロット，上り制御用スロットからなる通信フレームを用いてアクティブ方式にて車載器との通信を行いう路側通信手段に加えて、上り制御用スロットの期間、及びパッシブ方式の車載器に割り当てられたデータ用スロット内の下り信号に続く期間に無変調の搬送波を送信する搬送波送信手段を設け、路側通信手段は、搬送波を変調することでパッシブ方式の車載器から返送されてくる応答信号を、アクティブ方式の車載器からの上り信号と同等のものとして処理するように構成すればよい。

【0031】同じく請求項9記載の路車間通信システムにおいて、アクティブ方式の車載器は、従来のものをそのまま用いることができるが、パッシブ方式の車載器は、例えば請求項11記載のように、路上機の通信エリアに進入すると、第1応答手段が、下り制御用スロットをポーリング信号とみなして、上り制御用スロットの期間に送信されてくる無変調の搬送波を、ポーリング信号に対する応答信号にて変調し返送し、第2応答手段が、下り制御用スロットにて当該車載器に対するデータ用スロットの割当が示されている場合、割り当てられたデータ用スロットの期間に受信する下り信号を問合信号とし、その下り信号に引き続いて送信されてくる無変調の搬送波を、問合信号に対する応答信号にて変調し返送するように構成すればよい。

【0032】次に、請求項12記載の車載器では、車両の走行経路の近傍に設置された路上機との通信のために車両に搭載され、前記路上機から受信した信号の周波数帯を識別する周波数識別手段では、電界強度測定手段が、設定された周波数帯の電界強度を測定し、この電界強度測定手段にて測定対象となる周波数帯を、周波数切替手段が、予め設定された切替パタンに従って順次切り替える。

【0033】但し、その切替パタンは、限定された時間内に処理を完結させなければならない特定アプリケーション用に割り当てられた周波数帯の出現頻度が高くなるよう設定されている。このように、本発明の車載器によれば、特定アプリケーション用の周波数帯の検知機会を多くして、該周波数帯を優先的に調べているため、路上機から特定アプリケーションが提供されている時には、これを速やかに検知して速やかに処理を開始することが可能となる。その結果、通信リトライ用の余裕時間を十分に確保でき、特定アプリケーションの信頼性を低下させることなく、多様なアプリケーションにも対処することができる。

【0034】なお、請求項13記載のように、周波数切替手段は、設定された単位ユニット時間毎に測定対象となる周波数帯を切り替えると共に、速度取得手段にて取得される走行速度が早いほど、単位ユニット時間が短くなるよう該単位ユニット時間を変化させるように構成してもよい。

【0035】即ち、走行速度が早いほど、車両が通信エリアを通過するのに要する時間が短くなるが、このように単位ユニット時間を調整することにより、使用周波数の特定に要する時間を短縮すれば、処理に割り当てる時間を確保することができる。また、請求項14記載のように、記憶手段に、予め区分けされた各区域内に設置された路上機が路車間通信に使用する周波数帯についての情報を含む路上機情報を記憶させ、この記憶手段に記憶された路上機情報に基づき、切替パタン設定手段が、位置取得手段にて取得した現在位置から、周波数識別手段にて探索対象となる周波数帯を絞り込んで、切替パタンを設定するように構成してもよい。

【0036】この場合、路上機が使用していない周波数帯を無駄に測定することがなく、使用周波数の特定に無駄な時間をかけてしまうことを確実に防止でき、処理時間も十分に確保できるため、特定アプリケーションを実行する際の信頼性を一層向上させることができる。

【0037】なお、特定アプリケーションは、比較的早い速度で通信エリアを通過する車両に対して処理を行うものであればよく、例えば請求項15記載のように、ETCに関する処理であってもよいし、請求項16記載のように、電子ナンバープレートに関する処理であってもよい。

【0038】また、請求項12乃至請求項16のいずれかに記載の発明を、請求項1乃至請求項11のいずれかに記載の発明と組み合わせてもよいことは言うまでもない。

【0039】

【発明の実施の形態】以下に本発明の実施形態を図面と共に説明する。

[第1実施形態] 図1は、アクティブ方式の路車間通信によりETCアプリケーションの提供を行う路上機、パッシブ方式の路車間通信によりETCアプリケーションの提供を行う路上機が混在する第1実施形態の路車間通信システムにおいて、いずれの路上機とも通信可能な車載器の構成を表すブロック図である。

【0040】なお、アクティブ方式の路車間通信、及びパッシブ方式の路車間通信では、いずれも図22に示す周知の通信フレームが使用されるものとする。即ち、アクティブ方式の路車間通信では、3台の車載器との同時通信が可能なように3個のメッセージデータスロット（MDS）を備え、そのMDSの前に、路上機が車載器に対してMDSの割当状態を通知するためのフレームコントロールメッセージチャネル（FCM）、MDSの後に、車載器が路上機に対して存在を知らせるためのアクティベーションスロット（ACTS）とからなる通信フレームが用いられている（図22（a）参照）。なお、FCM，MDS，ACTSがそれぞれ本発明における下り制御用スロット，データ用スロット，上り制御用スロットに相当する。

【0041】また、パッシブ方式の路車間通信では、路上機が車載器に所望のデータを送信させるためのポーリング信号、問合信号を送信した後、引き続き予め設定された期間だけ無変調の搬送波を送信し、この搬送波をポーリング信号や問合信号に対応した応答信号にて変調して返送する方法が用いられている（図22（b）参照）。

【0042】但し、従来技術の欄にて説明したように（図21参照）、アクティブ方式において、路上機から車載器への下り信号用のダウンリンクでは二つの周波数帯Fad1，Fad2、車載器から路上機への上り信号用のアップリンクでは二つの周波数帯Fau1，Fau2がそれ

ぞれ使用され、一対の周波数帯Fad1とFau1（二つを総称する場合はFa1）、又はFad2とFau2（同じくFa2）のいずれかを用いて双方向の通信を行うようにされている。また、パッシブ方式では四つの周波数帯Fp1～Fp4が使用され、いずれか一つの周波数帯を用いて双方向の通信を行うようにされている。

【0043】以下では、他の周波数帯との重なりのない周波数帯Fp4を、パッシブ専用周波数帯とよび、周波数帯Fad1～Fad2（即ちFp1～Fp3が含まれる）を、共用周波数帯とよぶ。図1に示すように、本実施形態の車載器10は、アンテナ11にて受信された受信信号から、指定された特定周波数帯の信号成分を抽出し、その受信レベル（電界強度）を測定する電界強度検出部12と、アンテナ11を介してアクティブ方式にて路上機との通信を行う第1車側通信手段としてのアクティブ通信部13と、アンテナ11を介してパッシブ方式にて路上機との通信を行う第2車側通信手段としてのパッシブ通信部14と、周知のマイクロコンピュータを中心に構成され、上記各部12～14を制御し、路上機との通信により得られたデータの処理等を実行するデータ処理部15とを備えている。なお、データ処理部15には、図示しないが、料金精算のためにICカードリーダライタ等を備えた課金処理装置が接続される。

【0044】ここでデータ処理部15が実行するメイン処理を、図2に示すフローチャートに沿って説明する。本処理が起動すると、まず電界強度検出部12に測定指令を出力し、周波数帯Fad1の下限周波数から周波数帯Fp4の上限周波数までをスキャンさせ（S110）、測定した電界強度が予め設定された下限値以上であるか否かを監視する（S120）。

【0045】電界強度が下限値より小さければ、S110に戻って測定を繰り返し、電界強度が下限値以上であれば、当該車載器10を搭載した車両が路上機の通信エリアに進入したものとして、その時の周波数を検出周波数として記憶し（S130）、その検出周波数がパッシブ専用周波数帯Fp4に属しているか否かを判断する（S140）。

【0046】検出周波数がパッシブ専用周波数帯Fp4に属していなければ、検出周波数が属する周波数帯を、アクティブ方式のダウンリンク用周波数帯Fad1，Fad2の中から特定し、その特定された周波数帯Fadi（i＝1又は2）、及びこれと対になるアップリング用の周波数帯Fauiを用いて通信を行うようアクティブ通信部13を設定し、これを起動することにより（S150）、アクティブ方式による路車間通信を開始させる。

【0047】その後、アクティブ通信部13による通信が終了したか否かを判断し（S160）、通信が終了すると、その終了が、信号は受信するが内容を解析できない解析不能によるものか否かを判断する（S170）。そして、通信終了が解析不能によるものでなければ、そ

のままS110に戻り、一方、解析不能によるものであれば、先のS130にて記憶された検出周波数が属する周波数帯を、パッシブ方式用の周波数帯Fp1～Fp4の中から特定し、その特定された周波数帯を用いて通信を行うようパッシブ通信部14を設定し、これを起動することにより（S180）、パッシブ方式による路車間通信を開始させる。

【0048】その後、パッシブ通信部14による通信が終了したか否かを判断し（S190）、通信が終了するとS110に戻る。一方、S140にて、検出周波数がパッシブ専用周波数帯に属していると判断された場合には、S180に移行し、以下、先に説明した通りパッシブ通信部14を設定，起動し、パッシブ方式による路車間通信を開始させる。但し、この場合、通信には周波数帯Fp4が使用されることになる。

【0049】なお、本処理において、S150～S190が本発明における車側切替制御手段に相当し、S110，S120及び電界強度検出部12が，周波数識別手段に相当する。つまり、本処理では、電界強度が下限値以上となる検出周波数が、パッシブ専用周波数帯に属する場合には、直ちにパッシブ方式による路車間通信を行い、それ以外の共用周波数帯に属する場合には、最初、アクティブ方式による路車間通信を試み、受信信号を解析できず通信に失敗した場合には、パッシブ方式に切り替えて路車間通信を行うようにされている。

【0050】ここで、アクティブ通信部13の動作を、図3に示すフローチャートに沿って説明する。図示の如く、アクティブ通信部13が起動すると、まず、アンテナ11を介して何等かの信号を受信したか否かを判断し（S210）、信号を受信していれば、その信号はFCMであるか否かを判断する（S220）。

【0051】そして、受信した信号がFCMである場合には、その内容を解析し、自車両に対してMDSが割り当てられているか否かを判断し（S230）、割り当てられていなければ、ACTSの送信タイミングを待って（S240）、自車両（車載器10）の存在を路上機に知らせるための応答データの送信（S250）を行った後、S210に戻る。この応答データには、少なくとも当該車載器10或いは当該車載器10を搭載した車両を特定するための識別番号（以下「車両ID」という）が含まれている。

【0052】一方、FCMの内容を解析した結果、自車両に対してMDSが割り当てられていれば（S230－YES）、その割り当てられたMDSのタイミングまで待機し（S260）、そのタイミングで下り信号を受信したか否か、また受信した下り信号の内容であるMDSコマンドが正常なものであるか否かを判断する（S270）。

【0053】そして、下り信号を受信できないか、又は受信したとしてもMDSコマンドに異常がある場合に

は、そのままS210に戻り、一方、下り信号を受信し、且つMDSコマンドが正常であった場合には、そのMDSコマンドに対する応答データを送信する（S280）。この応答データの送信により、予め設定された手順に従った一連の通信が完了したか否かを判断し（S300）、通信が完了したのであれば、データ処理部15を構成するメモリの所定エリアに、通信が正常に終了したことを示す通信結果を記憶（S310）した後、アクティブ通信部13の動作を停止し、未だ通信が完了していないのであれば、そのままS210に戻る。

【0054】先のS220にて、受信した信号がFCMではない場合には、アクティブ方式のフォーマットに従って解析可能な信号であるか否かを判断し（S320）、解析不能であれば、通信終了の終了理由として解析不能通知を出力（S330）した後、アクティブ通信部13の動作を停止する。この場合、先に説明したメイン処理のS180にて肯定判定されるため、引き続きパッシブ方式での路車間通信が試みられることになる。

【0055】また、受信した信号がFCMではないが、アクティブ方式のフォーマットによって解析可能な信号である場合（S320－NO）、或いは信号を受信できない場合（S210－NO）には、アクティブ通信部13を起動後、或いは最後にFCMを受信後に、予め設定されたロック時間以上経過したか否かを判断し（S340）、ロック時間をまだ経過していなければ、そのままS210に戻り、一方、ロック時間以上経過していれば、アクティブ通信部13の動作を停止する。この場合、メイン処理のS180にて否定判定されるため、パッシブ方式での路車間通信が試みられることなく、直ちに周波数スキャン（S110）に戻ることになる。

【0056】次に、パッシブ通信部14の動作を、図4に示すフローチャートに沿って説明する。図示の如く、パッシブ通信部14が起動されると、まず、アンテナ11を介して何等かの信号を受信したか否かを判断し（S410）、信号を受信していれば、それがポーリング信号や問合信号といった正常なものであるか否かを判断する（S420）。

【0057】受信した信号が正常なものでなければ、そのままS410に戻り、一方、受信した信号が正常なものであれば、これに続けて送信されてくる搬送波を予め用意されている応答信号にて変調し、アンテナ11を介して返送する（S430）。この応答信号の送信により、予め設定された手順に従った一連の通信が完了したか否かを判断し（S440）、通信が完了したのであれば、通信結果をメモリの所定エリアに記憶（S450）した後、パッシブ通信部14の動作を停止し、未だ通信が完了していないのであれば、そのままS410に戻る。

【0058】一方、信号を受信できない場合（S410－NO）には、パッシブ通信部14を起動後、或いは最

15

後にポーリング信号又は問合信号を受信した後に、予め設定されたロック時間以上経過したか否かを判断し（Ｓ４６０）、ロック時間をまだ経過していなければ、そのままＳ４１０に戻り、一方、ロック時間以上経過していれば、パッシブ通信部１４の動作を停止する。

【００５９】なお、Ｓ４３０及び先のＳ２５０，Ｓ２８０における応答信号／応答データは、データ処理部１５にて別途実行される路車間通信を利用したアプリケーションプログラムによって適宜設定される。以上説明したように、本実施形態の車載器１０においては、アクティブ方式による路車間通信が可能なアクティブ通信部１３、及びパッシブ方式による路車間通信が可能なパッシブ通信部１４を備え、路上機の通信エリアに進入した時には、両通信部１３，１４を順次切り替えるサーチ動作を行い、通信可能となる方を用いて，路上機との路車間通信を行うようにされている。

【００６０】従って、本実施形態の車載器１０によれば、路上機がアクティブ方式，パッシブ方式のいずれで路車間通信を行うものであっても、これと確実に通信を行うことができる。しかも、本実施形態では、路上機が路車間通信に使用する周波数帯が、パッシブ専用周波数帯である場合には、サーチ動作を行うことなく、直ちにパッシブ方式による路車間通信を開始させているので、通信開始までに要する平均時間を短縮することができる。

【００６１】なお、本実施形態では、周波数スキャンにより検出された検出周波数が、共用周波数帯に属している場合，まず，アクティブ通信部１３を起動して、アクティブ方式による路車間通信を試み、通信できなかった場合に、パッシブ通信部１４に切り替えて、パッシブ方式による路車間通信を試みるようにされているが、両通信部１３，１４を同時に動作させ、正常な出力が得られる方を選択して、通信を行うようにしてもよい。

【００６２】この場合、メイン処理は、図５に示すように、図２に示すフローチャートからＳ１７０を省略すると共に、アクティブ通信部１３のみを起動するＳ１５０の代わりに、検出周波数に基づいて両通信部１３，１４の使用周波数帯の設定し，両通信部１３，１４を起動するＳ１５５を挿入すればよい。

【００６３】また、この場合、両通信部１３，１４の同時起動後、少なくとも一方は、ロック時間が経過すれば動作を停止するが，ロック時間が比較的長い場合には、いずれか一方の通信部が、有効な信号を最初に受信した時点（Ｓ２２０－ＹＥＳ，Ｓ４２０－ＹＥＳ）で、他方の通信部の動作を強制的に停止させるように構成してもよい。この場合、Ｓ１５５、及び通信できない側を停止させる処理が、本発明における選択制御手段に相当する。

【００６４】また、本実施形態では、アクティブ通信部１３及びパッシブ通信部１４にて、ロック時間が経過することにより動作を終了した場合に、特に何の処理も行っていないが、例えば、外部に設けられた警報装置（ランプやブザーなど）を作動させるようにしてもよい。

［第２実施形態］次に第２実施形態について説明する。

【００６５】図６は、アクティブ方式にて路車間通信を行う車載器、パッシブ方式にて路車間通信を行う車載器が混在する第２実施形態の路車間通信システムにおいて、有料道路の料金所の各車線毎に設けられる路上機の構成を表すブロック図である。なお、図６において、（ａ）は、いずれの通信方式の車載器とも通信可能な共用路上機であり、（ｂ）は、アクティブ方式の車載器とのみ通信可能なアクティブ専用路上機、（ｃ）は、パッシブ方式の車載器とのみ通信可能なパッシブ専用路上機である。また、通信フレームや、通信に使用する周波数帯は、第１実施形態の場合と同様である。

【００６６】まず共用路上機２０ａは、図６（ａ）に示すように、アンテナ２１を介してアクティブ方式の車載器との路車間通信を行う第１路側通信手段としてのアクティブ通信部２２と、アンテナ２３を介してパッシブ方式の車載器との路車間通信を行う第２路側通信手段としてのパッシブ通信部２４と、両通信部２２，２４の動作タイミングを制御する路側切替制御手段としてのタイミング制御部２５と、周知のマイクロコンピュータを中心に構成され、両通信部２２，２４が車載器との路車間通信にて送受するデータの処理等を実行するデータ処理部２６とを備えている。

【００６７】次に、アクティブ専用路上機２０ｂは、図６（ｂ）に示すように、共用路上機２０ａからアンテナ２３及びパッシブ通信部２４を省略した構成を有しており、また、パッシブ専用路上機２０ｃは、図６（ｃ）に示すように、共用路上機２０ａからアンテナ２１及びアクティブ通信部２２を省略した構成を有している。

【００６８】そして、料金所では、これらの路上機２０（２０ａ～２０ｃ）を適宜組み合わせることで構成され、図示しないが、各路上機２０のタイミング制御部２５は、互いに連動するように構成されている。ここで、路上機２０ａ，２０ｂにおけるアクティブ通信部２２の動作を、図７に示すフローチャートに沿って説明する。なお、アクティブ通信部２２は、タイミング制御部２５からの指令に従って起動する。

【００６９】図示の如く、アクティブ通信部２２が起動すると、まず、データ処理部２６により予めデータが設定されたＦＣＭを送信し（Ｓ５１０）、続けて各ＭＤＳ毎に、そのＭＤＳが割り当てられた車載器との間でデータの送受を行うＭＤＳ処理を実行する（Ｓ５２０）。

【００７０】その後、ＡＣＴＳのタイミングで車載器からの応答データ（車両ＩＤ）を受信したか否かを判断し（Ｓ５３０）、受信していなければ、そのまま本処理を終了する。一方、応答データを受信していれば、データ処理部２６を構成するメモリの所定エリアに、その応答

17

データの内容である車両ＩＤと応答数とを記憶して（Ｓ５４０）、本処理を終了する。

【００７１】このＳ５４０にて記憶された車両データと応答数とに基づき、データ処理部２６では、ＭＤＳの割当を行うＭＤＳ割当処理を実行し、次の通信フレームのＦＣＭにて送信される（即ちＳ５１０にて使用される）データの設定を行うと共に、車載器との通信に割り当てられたＭＤＳの状態を、「スロット使用中」に設定する等の処理を実行する。

【００７２】次に、先のＳ５２０におけるＭＤＳ処理の詳細を、図８に示すフローチャートに沿って説明する。本処理は、各ＭＤＳのタイミング毎に（即ち本実施形態では３回）繰り返し実行されるものとする。図示の如く、ＭＤＳ処理が起動されると、まず、データ処理部２６によるＭＤＳ割当処理の結果、現在処理の対象となっているＭＤＳの状態が「スロット使用中」である否かを判断し（Ｓ６１０）、「スロット使用中」でなければ、そのまま本処理を終了する。一方、当該ＭＤＳの状態が「スロット使用中」であれば、そのＭＤＳのタイミングにて、予め用意されているＭＤＳコマンドの送信（Ｓ６２０）と、車載器からの応答データの受信（Ｓ６３０）を行い、受信した応答データが、送信したＭＤＳコマンドに対応した正常なものであるか否かを判断する（Ｓ６４０）。

【００７３】応答データが正常なものであれば、その応答データの受信によって、予め設定されたシーケンスに従った一連の通信が完了したか否かを判断し（Ｓ６５０）、通信が完了していなければ、次シーケンスの準備（Ｓ６２０にて送信すべきＭＤＳコマンドの設定等）を行って（Ｓ６６０）、本処理を終了する。一方、通信が完了していれば、データ処理部２６を構成するメモリの所定エリアに、通信が正常に終了したことを示す通信結果を記憶して（Ｓ６７０）、本処理を終了する。

【００７４】先のＳ６４０にて、応答データに異常があれば、リトライ回数のカウント値が上限値より大きいか否かを判断し（Ｓ６８０）、上限値以下であれば、当該処理が次回起動された時に、今回送信したものと同じＭＤＳコマンドが先のＳ６２０にて送信されるようリトライ設定して（Ｓ６９０）、本処理を終了する。一方、リトライ回数のカウント値が上限値より大きければ、データ処理部２６を構成するメモリの所定エリアに、通信が異常終了したことを示す通信結果を記憶して（Ｓ７００）、本処理を終了する。

【００７５】このように、アクティブ通信部２２では、ＡＣＴＳのタイミングで応答した車載器に対してＭＤＳを割り当て、ＭＤＳ毎に異なった通信を行うことにより、最大３つの車載器との同時通信が可能なようにされている。次に、パッシブ通信部２４の動作を、図９に示すフローチャートに沿って説明する。なお、パッシブ通信部２４は、アクティブ通信部２２と同様に、タイミング制御部２５からの指令に従って起動する。

【００７６】図示の如く、パッシブ通信部２４が起動すると、まず、パッシブ方式の車載器と通信中であることを示す「パッシブ通信中」の設定が成されているか否かを判断し（Ｓ７１０）、「パッシブ通信中」でなければ、ポーリング信号を送信し（Ｓ７２０）、引き続き所定期間だけ搬送波を送信して、車載器からの応答（車両ＩＤを表す応答信号にて搬送波を変調したもの）を受信する（Ｓ７３０）。

【００７７】このとき、受信した応答信号の内容がポーリング信号に対応した正常なものであるか否かを判断し（Ｓ７４０）、正常ではない場合には、そのまま本処理を終了する。一方、受信した応答信号の内容が正常であれば、データ処理部２６を構成するメモリの所定エリアに、応答信号に示された車載ＩＤを記憶して、「パッシブ通信中」の設定を行い（Ｓ７５０）、次シーケンスの準備（後述するＳ７７０にて送信すべき問合信号の設定）を行って（Ｓ７６０）、本処理を終了する。

【００７８】先のＳ７１０にて、「パッシブ通信中」の設定がなされていれば、予め用意されている問合信号を送信し（Ｓ７７０）、引き続き所定期間だけ搬送波を送信して、車載器からの応答（応答信号にて搬送波を変調したもの）を受信する（Ｓ７８０）。

【００７９】このとき、受信した応答信号の内容が、Ｓ７７０にて送信した問合信号に対応した正常なものであるか否かを判断し（Ｓ７９０）、正常であれば、その応答信号の受信によって、予め設定されたシーケンスに従った一連の通信が完了したか否かを判断し（Ｓ８００）、通信が完了していなければ、次のシーケンスの準備を行って（Ｓ７６０）、本処理を終了する。一方、通信が完了していれば、データ処理部２６を構成するメモリの所定エリアに、通信が正常に終了したことを示す通信結果を記憶し、「パッシブ通信中」の設定を解除して（Ｓ８１０）、本処理を終了する。

【００８０】先のＳ７９０にて、受信した応答信号に異常があれば、リトライ回数のカウント値が上限値より大きいか否かを判断し（Ｓ８２０）、上限値以下であれば、当該処理が次回起動された時に、今回送信したものと同じ問合信号が先のＳ７７０にて送信されるようリトライ設定（Ｓ８３０）した後、本処理を終了する。一方、リトライ回数のカウント値が上限値より大きければ、データ処理部２６を構成するメモリの所定エリアに、通信が異常終了したことを示す通信結果を記憶し、「パッシブ通信中」の設定を解除して（Ｓ８４０）、本処理を終了する。

【００８１】このように、パッシブ通信部２４では、ポーリング信号に応答した車載器の中のいずれか一つと通信を行うようにされている。次に、３つの車線Ｌ１～Ｌ３を有する料金所を例にして、路上機２０ａ～２０ｃの組合せと、その動作タイミング、即ちタイミング制御部

２５の制御内容について説明する。

【００８２】まず、図１０（ａ）に示す料金所Ｍ１では、車線Ｌ１，Ｌ２に共用路上機２０ａ、車線Ｌ３にパッシブ専用路上機２０ｃを設置し、しかも、車線Ｌ１，Ｌ２では、アンテナ２１によるアクティブ方式用の通信エリアと、アンテナ２３によるパッシブ方式用の通信エリアとが、空間的に離され、互いに重なり合うことのないように設定されている。但し、図中には、各路上機の構成のうちアンテナのみが記載されている（以下、図１１，図１２でも同様）。

【００８３】また、車線Ｌ１の共用路上機２０ａでは、パッシブ通信用に周波数帯Ｆｐ１，アクティブ通信用に周波数帯Ｆａ２、車線Ｌ２の共用路上機２０ａでは、パッシブ通信用に周波数帯Ｆｐ２，アクティブ通信用に周波数帯Ｆａ１、車線Ｌ３のパッシブ専用路上機２０ｃでは、パッシブ通信用に周波数帯Ｆｐ３が割り当てられている。

【００８４】なお、アクティブ方式で用いるフレームの１周期（以下「アクティブ区間」という）と、パッシブ方式でポーリング信号又は問合信号の送出開始後、搬送波の送出を停止するまでの１周期（以下「パッシブ区間」という）とが、同じ長さに設定されている。

【００８５】そして、図１０（ｂ）に示すように、車線Ｌ１，Ｌ２の各共用路上機２０ａのタイミング制御部２５は、いずれも、同一車線内において、ポーリング信号又は問合信号の送出タイミングと、ＦＣＭの送出タイミングとが異なるように、両通信部２２，２４の動作タイミングを制御する。

【００８６】また、車線Ｌ１～Ｌ３の各路上機２０のタイミング制御部２５は連動して、車線Ｌ１，Ｌ３と車線Ｌ２とでポーリング信号又は問合信号の送出タイミングが互いに異なり、また、車線Ｌ１と車線Ｌ２とでＦＣＭの送出タイミングが互いに異なるように、各通信部２２，２４の動作タイミングを制御する。

【００８７】以上のように構成された料金所Ｍ１において、共用路上機２０ａを使用する車線Ｌ１，Ｌ２では、アクティブ方式の通信エリアとパッシブ方式の通信エリアとを空間的に分離し、互いに干渉を起こすことがないようにされているので、アクティブ及びパッシブいずれの通信方式の車載器とも、良好な通信品質を確保でき、車載器の通信方式によらず路車間通信を介した料金自動収受を確実に行うことができる。

【００８８】なお、上記料金所Ｍ１において、共用路上機２０ａを使用する車線Ｌ１，Ｌ２では、同一車線のアクティブ方式とパッシブ方式とに割り当てる周波数帯を、互いに重なり合わないものを選択して組み合わせているが、互いに重なり合うものを選択して組み合わせてもよい。つまり、このように通信エリアが空間的に分離されている場合、共用路上機２０ａにおける両通信方式の周波数帯の組合せは任意である。

【００８９】次に、図１１（ａ）に示す料金所Ｍ２では、車線Ｌ１に共用路上機２０ａ、車線Ｌ２にパッシブ専用路上機２０ｃ、車線Ｌ３にアクティブ専用路上機２０ｂを設置し、しかも、車線Ｌ１では、アンテナ２１によるアクティブ方式用の通信エリアと、アンテナ２３によるパッシブ方式用の通信エリアとが、互いに重なり合うように設定されている。

【００９０】また、車線Ｌ１の共用路上機２０ａでは、パッシブ通信用に周波数帯Ｆｐ４，アクティブ通信用に周波数帯Ｆａ１、車線Ｌ２のパッシブ専用路上機２０ｃではパッシブ通信用に周波数帯Ｆｐ１、車線Ｌ３のアクティブ専用路上機２０ｂではアクティブ通信用に周波数帯Ｆａ２が割り当てられている。なお、先に説明した料金所Ｍ１の場合と同様に、アクティブ区間とパッシブ区間とは、同じ長さに設定されている。そして、図１１（ｂ）に示すように、車線Ｌ１の共用路上機２０ａのタイミング制御部２５では、両通信部２２，２４を並列動作させ、しかもポーリング信号又は問合信号の送出タイミングと、ＦＣＭの送出タイミングとが同時となるように、両通信部２２，２４の動作タイミングを制御する。

【００９１】また、車線Ｌ１～Ｌ３の各路上機２０のタイミング制御部２５は連動し、車線Ｌ１，Ｌ３と車線Ｌ２とで、ポーリング信号又は問合信号の送出タイミング、及びＦＣＭの送出タイミングが互いに異なるように、各通信部２２，２４の動作タイミングを制御する。以上のように構成された料金所Ｍ２において、共用路上機２０ａを使用する車線Ｌ１では、アクティブ方式とパッシブ方式とで同一の通信エリアを周波数分割にて使用し、互いに干渉を起こすことがないようにされているので、アクティブ及びパッシブいずれの通信方式の車載器とも、良好な通信品質を確保でき、車載器の通信方式によらず路車間通信を介した料金自動収受を確実に行うことができる。

【００９２】また、料金所Ｍ２では、アクティブ方式とパッシブ方式とで同一の通信エリアを使用しているため、両通信方式の通信エリアが空間的に分離されている料金所Ｍ１と比較して、設備を小さくすることができる。なお、上記料金所Ｍ２において、両通信方式が可能な車線Ｌ１の共用路上機２０ａでは、パッシブ通信用に周波数帯Ｆｐ４，アクティブ通信用に周波数帯Ｆａ１を用いているが、周波数帯が重なり合わなければよいため、アクティブ通信用に周波数帯Ｆａ１を用いた場合には、パッシブ通信用に周波数帯Ｆｐ２，Ｆｐ３を用いてもよく、また、アクティブ通信用に周波数帯Ｆａ２を用いた場合には、パッシブ通信用に周波数帯Ｆｐ１，Ｆｐ４を用いてもよい。

【００９３】次に、図１２（ａ）に示す料金所Ｍ３では、車線Ｌ１，Ｌ２に共用路上機２０ａ、車線Ｌ３にパッシブ専用路上機２０ｃを設置し、しかも、車線Ｌ１，Ｌ２では、アンテナ２１によるアクティブ方式用の通信

エリアと、アンテナ２３によるパッシブ方式用の通信エリアとが、互いに重なり合うように設定されている。

【００９４】また、車線Ｌ１の共用路上機２０ａでは、パッシブ通信用に周波数帯Ｆｐ１，アクティブ通信用に周波数帯Ｆａ２、車線Ｌ２の共用路上機２０ａでは、パッシブ通信用に周波数帯Ｆｐ２，アクティブ通信用に周波数帯Ｆａ１、車線Ｌ３のパッシブ専用路上機２０ｃでは、パッシブ通信用に周波数帯Ｆｐ４が割り当てられている。なお、先に説明した料金所Ｍ１の場合と同様に、アクティブ区間とパッシブ周期とは、同じ長さに設定されている。そして、図１２（ｂ）に示すように、車線Ｌ１，Ｌ２の各共用路上機２０ａのタイミング制御部２５は、いずれも、アクティブ区間とパッシブ区間とが交互に現れるよう、即ち同一通信エリアを時分割して使用するように、両通信部２２，２４の動作タイミングを制御する。

【００９５】また、車線Ｌ１～Ｌ３の各路上機２０のタイミング制御部２５は連動し、車線Ｌ１，Ｌ３と車線Ｌ２とで、ポーリング信号又は問合信号の送出タイミング、及びＦＣＭの送出タイミングが互いに異なるように、各通信部２２，２４の動作タイミングを制御する。

【００９６】以上のように構成された料金所Ｍ３において、共用路上機２０ａを使用する車線Ｌ１，Ｌ２では、アクティブ方式とパッシブ方式とで同一の通信エリアを時分割にて使用し、互いに干渉を起こすことがないようにされているので、アクティブ及びパッシブいずれの通信方式の車載器とも、良好な通信品質を確保でき、車載器の通信方式によらず路車間通信を介した料金自動収受を確実に行うことができる。

【００９７】また、料金所Ｍ３では、アクティブ方式とパッシブ方式とで同一の通信エリアを使用しているため、両通信方式の通信エリアが空間的に分離されている料金所Ｍ１と比較して、設備を小さくすることができる。なお、上記料金所Ｍ３において、共用路上機２０ａを使用する車線Ｌ１，Ｌ２では、同一車線のアクティブ方式とパッシブ方式とに割り当てる周波数帯を、互いに重なり合わないものを選択して組み合わせているが、互いに重なり合うものを選択して組み合わせてもよい。つまり、このように通信エリアを時分割で使用する場合、共用路上機２０ａにおける両通信方式の周波数帯の組合せは任意である。

【００９８】また、上記各例におけるタイミング制御部２５は、アクティブ区間とパッシブ区間とが連続するように制御しているが、これら両区間の間にいずれの方式の送受信も行わないブランク区間が挿入されるように制御してもよい。ところで、上記料金所Ｍ３における共用路上機２０ａでは、両通信部２２，２４の動作を、アクティブ区間及びパッシブ区間単位、即ち通信フレーム単位で切り替えているが、例えば、図１３（ａ）に示すように、アクティブ通信部２２では、その通信フレームの

複数あるＭＤＳのうちの一つ（ここではＭＤＳ０）を使用禁止とし、パッシブ通信部２４では、パッシブ区間の長さを一つのＭＤＳに収まる大きさに設定し、タイミング制御部２５では、このＭＤＳ０の期間に、パッシブ通信部２４を動作させるように構成してもよい。

【００９９】なお、パッシブ通信部２４を動作させるために割り当てるＭＤＳの数は、２個以上でもよく、例えば、図１３（ｂ）に示すように、複数設定されたＭＤＳ（ここでは８個）のうち、アクティブ通信部２２では、偶数番目（０，２，４，６）に位置する半数のＭＤＳを使用可能とし、奇数番目（１，３，５，７）に位置する残りの半数のＭＤＳを使用禁止として、タイミング制御部２５では、この使用禁止とされたＭＤＳの期間のそれぞれにて、パッシブ通信部２４を動作させるように構成してもよい。

【０１００】更に、パッシブ通信部２４を動作させるために割り当てるＭＤＳの数を、通信状態に応じて可変設定するように構成してもよい。この場合に、データ処理部２６にて実行されるＭＤＳ割当処理を、図１４に示すフローチャートに沿って説明する。但し、アクティブ通信部２２及びパッシブ通信部２４の動作は、図７～図９のフローチャートにて説明したものと全く同様である。

【０１０１】図示の如く、本処理が起動すると、アクティブ方式にて現在通信中の車載器の数ＣＡが、アクティブ方式にて同時通信可能な最大数ＳＡmax（ここでは２）より小さく（ＣＡ＜ＳＡmax）、新たなアクティブ方式の通信を開始させることが可能な空きＭＤＳがあるか否かを判断し（Ｓ９１０）、空きＭＤＳがあれば、先のＳ５４０にて記憶されたＡＣＴＳの応答データ（アクティブ方式の通信要求）があるか否かを判断する（Ｓ９２０）。

【０１０２】ＡＣＴＳの応答データがあれば、その中から、ＳＡmax－ＣＡ個を限度として新たにＭＤＳを割り当てる通信要求を選択し（Ｓ９３０）、一方、ＡＣＴＳの応答データがなければ、現在通信中のものがある（ＣＡ≧１）か否かを判断する（Ｓ９４０）。なおＳ９３０にて通信要求の選択が行われると、その分だけ、通信中の車載器の数ＣＡは増加する。

【０１０３】そして、現在通信中のものがあるか、先のＳ９１０で空きＭＤＳがないと判定されるか、或いは先のＳ９３０にて通信要求が選択された場合、次に送信する通信フレームにて、ＭＤＳを割り当てるべきアクティブ方式の通信が少なくとも一つはあるので、これらの通信（車両ＩＤにて識別される）に対して使用すべきＭＤＳの割当を行う（Ｓ９５０）。

【０１０４】このＭＤＳの割当が終了するか、或いは先のＳ９４０にてアクティブ方式にて現在通信中のものがないと判定された場合、今度は、パッシブ通信部２４の状態として「パッシブ通信中」が設定されているか否かを判断し（Ｓ９６０）、「パッシブ通信中」が設定され

ていれば、空きMDSがある（CA＜SAmax）か否かを判断する（S970）。

【0105】そして「バッシブ通信中」が設定されていなか、或いは空きMDSがない場合には、バッシブ通信用に予め確保されている一つのMDSを割り当てる基本割当を行って（S980）、本処理を終了する。一方、「バッシブ通信中」が設定されており、且つ空きMDSがある場合には、空きMDSのいくつか（ここでは2個を上限とする）をバッシブ通信用に割り当てる拡張割当を行って（S990）本処理を終了する。

【0106】ここで図15は、通信フレームを構成する3個のMDSのうち、バッシブ方式での通信用に一つのMDSを常時確保し、アクティブ方式での通信用に割当可能なMDSの最大数を2（＝SAmax）とした場合の通信フレームの状態を表したものである。上記MDS割当処理を実行することにより、バッシブ方式での通信がないか、又はアクティブ方式での通信に割当可能なMDSの全てが、アクティブ方式での通信に割り当てられている場合には、（a）に示すように、バッシブ通信用にMDSが1個だけ割り当てられる。また、バッシブ方式での通信があり、且つアクティブ方式での通信用に割り当てられたMDSが1個以下の場合には、（b）に示すように、バッシブ通信用にMDSが2個割り当てられることになる。

【0107】このようなMDS割当処理を行うことにより、アクティブ方式での通信に使用されない空きMDSがある場合、これがバッシブ方式での通信に有効利用されるため、共用路上機20aの処理能力を向上させることができる。なお、ここでは、バッシブ方式での通信（バッシブ通信部24）に割当可能なMDSの最大数を2としたが、アクティブ方式による通信がない場合に、全てのMDSをバッシブ方式での通信に割り当てるようにしてもよい。

〔第3実施形態〕次に、第3実施形態について説明する。

【0108】図16は、アクティブ方式にて路車間通信を行う車載器、バッシブ方式にて路車間通信を行う車載器が混在する本実施形態の路車間通信システムにおいて、有料道路の料金所の各車線毎に設けられる路上機の構成を表すブロック図である。図示の如く、本実施形態において路上機30は、バッシブ方式用の送信アンテナ31a，受信アンテナ31b、及びアクティブ方式用の送受信アンテナ32を備えている。そして、送受信アンテナ32に対する送受信信号を分離する方向性結合器33と、これらアンテナ31a，31b，32を介して信号を送受することにより車載器との路車間通信を行う路側通信手段としての共用通信部35と、共用通信部35からの切替信号Gに従って、共用通信部35からの送信信号を、送信アンテナ31a或いは方向性結合器33を介して送受信アンテナ32のいずれかに供給すると共に、受信アンテナ31b或いは方向性結合器33を介した送受信アンテナ32からの受信信号のいずれかを、共用通信部35に供給するアンテナ切替部34と、周知のマイクロコンピュータを中心に構成され、共用通信部35により車載器との間で送受されるデータの処理等を実行するデータ処理部36とを備えている。

【0109】そして、本実施形態の路車間通信システムでは、路上機30と車載器との間の路車間通信には、アクティブ，バッシブの通信方式に関わらず、アクティブ方式のものをベースにした共通の通信フレームが使用される。この通信フレームは、図17に示すように、FCM，複数のMDS（ここでは4個），ACTSからなる従来の通信フレームに、以下の変更が加えられている。

即ち、ACTSが前半部分と後半部分とに分割され、前半部分にてアクティブ方式の車載器からの応答（通信要求）を受け、後半部分では搬送波を送信することにより、バッシブ方式の車載器からの応答（FCMをポーリング信号とみなして、そのポーリングに対する応答）を受けることが可能なようにされている。

【0110】また、MDSを、アクティブ方式での通信、及びバッシブ方式での通信のいずれにも割り当てることを可能とし、バッシブ方式での通信用に割り当てられたMDSでは、下りコマンド（アクティブ方式のMDSコマンドと、バッシブ方式の問合信号を共通化したもの）の送信後、そのMDSの残りの期間の間、搬送波を送信することにより、バッシブ方式の車載器からの応答を受けることが可能なようにされている。

【0111】そして、アクティブ方式の車載器とは、従来と同様の方法（但し、車載器からの通信要求にはACTSの前半部分のみを使用）で通信を行い、一方、バッシブ方式の車載器とは、FCMをポーリング信号と見なして、ポーリング信号に対する応答信号を、ACTSの後半部分で返送し、以後、割り当てられたMDSを用いて通信を行う。

【0112】なお、共用通信部35は、バッシブ方式での通信用に割り当てられたMDSの期間、及びACTSの後半部分だけ、バッシブ用のアンテナ31a，31bを選択し、それ以外の期間では、アクティブ用のアンテナ32を選択するように、アンテナ切替部34を動作させる切替信号Xを生成するように構成されている。

【0113】ここで、共用通信部35における通信フレームの送受に関する動作を、図18に示すフローチャートに沿って説明する。但し、その内容は、第2実施形態のアクティブ通信部22の動作（図7参照）と一部異なっているだけであるため、同様の処理については、同一符号を付して説明を省略し、処理の相違する部分を中心に説明する。

【0114】図示の如く、共用通信部35では、FCMの送信（S510）、後述する各MDS毎の処理（S520）、ACTSタイミングでのアクティブ方式の車載器からの応答の処理（S530，S540）を行う。但し、第2実施形態におけるS510～S540について説明のうち、データ処理部26はデータ処理部36に、またアクティブ通信部22は共用通信部35に読み替えるものとする。

【0115】引き続き所定期間（ACTSの後半部分）だけ搬送波を送信し（S550）、バッシブ方式の車載器からの応答（ポーリングに対する応答データにて搬送波を変調したもの）があったか否かを判断する（S560）。そして、応答がなければそのまま本処理を終了し、一方、応答があった場合には、データ処理部36を構成するメモリの所定エリアに、その応答データ（車両ID）を記憶して（S670）本処理を終了する。

【0116】次にS520におけるMDS処理の詳細を、図19に示すフローチャートに沿って説明する。本処理は、各MDSのタイミング毎に繰り返し実行されるものとする。図示の如く、本処理が起動されると、先のS540及びS570にて記憶された応答データに基づいて、データ処理部36が実行するMDS割当処理の結果、現在処理の対象となっているMDSの状態が、アクティブ或いはバッシブいずれかの方式での通信に割り当てられた「スロット使用中」であるか否かを判断し（S610）、「スロット使用中」でなければ、そのまま本処理を終了する。一方、当該MDSの状態が「スロット使用中」であれば、そのMDSのタイミングにて、予め設定された下りコマンドを送信し（S620）、当該MDSがバッシブ方式の通信に割り当てられたものである場合（S622－YES）には、引き続き当該MDSの残りの期間だけ搬送波の送信を行って（S624）、車載器からの応答データを受信する（S630）。

【0117】以下、受信した応答データについて、第2実施形態にて説明したMDS処理におけるS640～S700と同様に処理を実行する。但し、S670，S700では、バッシブ通信が完了した場合に「バッシブ通信中」の設定を解除するものとする。また、第2実施形態での記載において、MDSコマンドは下りコマンドに、またデータ処理部26はデータ処理部36に読み替えるものとする。

【0118】なお、上記処理においてS550，S624が本発明における搬送波送信手段に相当する。次に、データ処理部36が実行するMDS割当処理を、図20に示すフローチャートに沿って説明する。

【0119】なお、第2実施形態にて説明したMDS割当処理（図14参照）では、バッシブ方式の車載器に対するポーリングを可能とするために、常に少なくとも一つのMDSが割り当てられているが、本実施形態では、FCM，ACTSにて、ポーリングに相当する処理を実行するため、バッシブ方式の場合にも、通信が開始された時のみMDSが割り当てられる点で異なっている。

【0120】本処理が起動されると、図示の如く、まずバッシブ方式により車載器との通信が行われていることを示す「バッシブ通信中」の設定がなされているか否かを判断し（S900）、「バッシブ通信中」でなければ、先のS570にて、ポーリングに対する応答データが記憶されているか否か、即ちバッシブ方式での通信要求があるか否かを判断し（S902）、バッシブ方式での通信要求があれば、その中から、通信を開始するものを一つだけ選択すると共に、「バッシブ通信中」の設定を行う（S904）。

【0121】そして、S900にて「バッシブ通信中」であると判定されるか、或いはS904にて、新たに「バッシブ通信中」が設定されると、バッシブ方式での通信用に、最低限（ここでは1個）のMDSを確保し（S906）、一方、「バッシブ通信中」ではなく、且つバッシブ方式での通信要求もない場合には、MDSを確保することなく、次ステップに進む。

【0122】以下、S910～S950は、第2実施形態での説明と同様に、アクティブ方式での通信に用いるMDSの割当を行う。但し、本実施形態において、アクティブ方式での通信用に割当可能な最大MDS数がSAmaxは、S906にてバッシブ方式での通信用にMDSが確保されていなければ、SAmax＝4であり、確保されていれば、その分だけ減少してSAmax＝3となる。

【0123】バッシブ方式用のMDSの割当が終了すると、「バッシブ通信中」が設定されているか否かを判断し（S960）、設定されていなければそのまま本処理を終了し、一方、設定されていれば、先のS906にて確保したMDS以外に、空きMDSがあるか、即ち、アクティブ方式用に割り当てられていないMDSが合計2個以上あるか否かを判断する（S970）。そして、空きMDSがなければ、バッシブ方式用に確保されている一つのMDSを割り当てる基本割当を行って（S980）、本処理を終了し、一方、空きMDSがある場合には、空きMDSもバッシブ方式用に割り当てる拡張割当を行って（S990）本処理を終了する。ところで、このようにアクティブ方式とバッシブ方式とで通信フレームを共通化したことにより、バッシブ方式の車載器は、処理を変更する必要があるが、その処理は、図3に示した、アクティブ通信部22とほぼ同様なものとなる。

【0124】但し、S250，S280での応答データの送信は、搬送波を変調することで行い、S260～S300の処理は、割り当てられたMDS毎に、繰り返し行うよう必要がある。このように改良されたS250，S280が、本発明における第1応答手段，第2応答手段にそれぞれ相当する。

【0125】以上、説明したように、本実施形態の路車間通信システムによれば、路上機30が、アクティブ，バッシブの通信方式に関わらず、統一的に処理を行うことができるため、通信方式毎に個別の通信部を設ける必要がなく、路上機30の構成を簡易化できる。

【０１２６】なお、路上機が受信する車載器からの電波の電界強度は、パッシブ方式ではアクティブ方式と比較して非常に小さなものとなっているため、共用通信部３５では、パッシブ方式用の受信アンテナ３１ｂから信号を受信する際には、その受信信号を増幅する増幅器の増幅率を増大させるように構成することが好ましい。勿論、逆に、アクティブ方式用の送受信アンテナ３２から信号を受信する際に、増幅器の増幅率を低下させるように構成してもよい。

【０１２７】また、本実施形態では、ＡＣＴＳを前半部分と後半部分とに分けて、アクティブ，パッシブの両通信方式の応答を時間的にずらして受信するようにされているが、アクティブ方式のアップリンクの周波数帯と、パッシブ方式の搬送波を送信する周波数帯とが異なっていれば、ＡＣＴＳの全期間に渡って搬送波を送出し、同時に応答を受信してもよい。但し、この場合、少なくともＡＣＴＳの期間では、２種類の周波数帯の信号を同時に受信して、その両方の信号を処理するように構成する必要がある。

［第４実施形態］次に第４実施形態について説明する。

【０１２８】図２３は、ＥＴＣアプリケーションをアクティブ方式或いはパッシブ方式にて提供する路上機、及びＥＴＣ以外のアプリケーションをアクティブ方式にて提供する路上機が混在する路車間通信システムにおいて、いずれの路上機とも通信可能な車載器の構成を表すブロック図である。

【０１２９】なお、アクティブ方式及びパッシブ方式の路車間通信では、アプリケーションの種類によらず、第１実施形態にて説明したものと同様の通信フレーム（図２２参照）が用いられている。但し、アクティブ方式の路車間通信によりＥＴＣアプリケーションを提供するの路上機は、図２１に示すように、ダウンリンク用及びアップリンク用の一対の周波数帯Ｆａｄ１とＦａｕ１（二つを総称する場合はＦａ１）、又はＦａｄ２とＦａｕ２（同じくＦａ２）のいずれかを用いて双方向の通信を行い、また、パッシブ方式の路車間通信によりＥＴＣアプリケーションを提供する路上機は、双方向に使用する四つの周波数帯Ｆｐ１～Ｆｐ４のいずれかを用いて双方向の通信を行う。

【０１３０】また、アクティブ方式の路車間通信にＥＴＣ以外のアプリケーションを提供する路上機は、ダウンリンク用及びアップリンク用の一対の周波数帯Ｆｅｄｊ，Ｆｅｕｊ（ｊ＝１～５）のいずれかを用いて双方向の通信を行うようにされている。なお、ＥＴＣ以外のアプリケーションを提供する路上機は、駐車場や公共施設の出入り口付近や、駐車場における車両の駐車位置付近、あるいは駐車場内の走行路付近など、車両が完全に停車しているか、極めて低速での移動が強要される場所に設置され、入退場管理や顧客サービスを提供するものとする。

【０１３１】図２３に示すように、本実施形態の車載器４０は、第１実施形態の車載器１０と同様に、アンテナ４１，電界強度検出部４２，アクティブ通信部４３，パッシブ通信部４４，データ処理部４５を備え、更に、後述する周波数割当情報、及び路上機情報を格納するメモリ４６を備えている。

【０１３２】このうち、アクティブ通信部４３は、ＥＴＣアプリケーション用、ＥＴＣ以外のアプリケーション用に関わらず、アクティブ方式用の各一対の周波数帯Ｆａ１，Ｆａ２，Ｆｅ１～Ｆｅ５のいずれかを用いて路上機との通信を行うように構成されている。

【０１３３】パッシブ通信部４４は、パッシブ方式用の周波数帯Ｆｐ１～Ｆｐ４のいずれか一つを使用し、アンテナ４１を介してパッシブ方式にて路上機との通信を行うと共に、通信フレームの受信の有無については、同時に二つの周波数帯について判定できるように構成されている。但し、本実施形態では、パッシブ方式用の４つの周波数帯Ｆｐ１～Ｆ４のうち、３つの周波数帯Ｆｐ１～Ｆｐ３のみを使用するものとする。

【０１３４】電界強度検出部４２は、図２１に示すように、アクティブ方式の通信に使用する周波数帯Ｆｅｄ１～Ｆｅｄ４，Ｆａｄ１，Ｆｅｄ５，Ｆａｄ２とそれぞれ一致するように設定された周波数帯Ｂ１～Ｂ７のいずれかについて、その電界強度を測定するように構成されている。従って、周波数帯Ｂ５の電界強度を測定した場合、周波数帯Ｆａｄ１，Ｆｐ１が関係し、周波数帯Ｂ６の電界強度を測定した場合、周波数帯Ｆｐ１，Ｆｐ２が関係し、周波数帯Ｂ７の電界強度を測定した場合、周波数帯Ｆａｄ２，Ｆｐ２，Ｆｐ３が関係することになる。

【０１３５】つまり、本実施形態では、周波数帯Ｂ５，Ｂ７の電界強度を測定することにより、ＥＴＣアプリケーション用の全ての周波数帯Ｆａｄ１，Ｆａｄ２，Ｆｐ１～Ｆｐ３の使用状態を検知することが可能となる。以下では、この周波数帯Ｂ５，Ｂ７を、ＥＴＣ周波数帯ともよぶ。

【０１３６】メモリ４６に記憶された周波数割当情報とは、アクティブ通信部４３，パッシブ通信部４４が路上機との通信に使用する各周波数帯毎に、通信方式（アクティブ方式／パッシブ方式）、アプリケーションの種類（ＥＴＣ／その他）、変調方式（ＡＳＫ／ＰＳＫ／ＱＰＳＫ）を対応づけて示したものである。また、路上機情報とは、予め区分けされた区域毎に、その区域に含まれる路上機がどの周波数帯を使用してアプリケーションの提供を行うかを示したものである。なお、区域は、例えば、各路上機毎に一つの区域を設定したり、高速道路など、車両の進入が制限される領域を一つの区域として設定することができる。

【０１３７】データ処理部４５は、周知のマイクロコンピュータを中心に構成され、ナビゲーション装置等から車両の現在位置を表す位置情報、また、車速センサの出力信号を処理するＥＣＵから車両の走行速度を表す速度情報を入力すると共に、メモリ４６に記憶された周波数割当情報や路上機情報に基づいて、上記各部４２，４３，４４を制御し、路上機との通信により得られたデータの処理等を実行する。

【０１３８】ここで、データ処理部４５が実行するメイン処理を、図２４に示すフローチャートに沿って説明する。本処理が起動すると、まず電界強度検出部１２を用いて路上機がサービスの提供に使用している周波数帯を特定するための周波数スキャンを実行し（Ｓ１０１０）、周波数スキャンにて周波数が特定されると、メモリ４６に記憶された周波数割当情報に基づき、アクティブ通信部１３及びパッシブ通信部１４の変調方式を、特定された周波数帯に対応するものに設定すると共に、それがＥＴＣアプリケーションを提供するために設けられたＥＴＣ周波数帯Ｂ５，Ｂ７のいずれかであるか否かを判断する（Ｓ１０２０）。

【０１３９】特定された周波数がＥＴＣ周波数帯であれば、アクティブ通信部１３及びパッシブ通信部１４の出力から、どちらの通信部１３，１４が通信フレームを解析できたかにより、通信に使用されている方式がアクティブ方式であるか否かを判断する（Ｓ１０３０）。そして、通信に使用されている方式がアクティブ方式であれば、アクティブ通信部１３を使用したアクティブ方式でのＥＴＣ処理を実行して（Ｓ１０４０）、Ｓ１０１０に戻り、一方、通信に使用されている方式がパッシブ方式であれば、パッシブ通信部１４を使用したパッシブ方式でのＥＴＣ処理を実行して（Ｓ１０５０）、Ｓ１０１０に戻る。

【０１４０】先のＳ１０２０にて、周波数スキャンによって特定された周波数帯が、ＥＴＣ周波数帯のものではなと判定された場合には、アクティブ通信部１３を介して受信したフレームのヘッダ部分にあるアプリケーションＩＤを抽出し、このアプリケーションＩＤに基づいて、路上機が提供しているアプリケーションが当該車載器にて処理可能なものであるか否かを判断し（Ｓ１０６０）、処理可能なものでなければ、そのままＳ１０１０に戻り、一方、処理可能なものであれば、アプリケーションＩＤに対応したアプリケーション処理を実行し（Ｓ１０７０）、Ｓ１０１０に戻る。

【０１４１】次に、Ｓ１０１０にて実行する周波数スキャンの詳細を、図２５に示すフローチャートに沿って説明する。本処理が起動すると、まず、外部のナビゲーション装置等から、車両の現在位置を表す位置情報を取得し（Ｓ１１１０）、その位置情報に基づいて、対応する区域の路上機情報をメモリから読み出し、その路上機情報に従って、切替パタン及び切替パタンの１周期を構成する単位ユニットの総数（以下「ユニット数」という）Ｕｍａｘを設定する（Ｓ１１２０）。

【０１４２】ここで、図２６（ａ）は、路上機情報から全ての周波数帯について測定が必要であると判定された場合に設定される切替パタンを示したものであり、ユニット数Ｕｍａｘは１５である。具体的には、２個の単位ユニットで、ＥＴＣ周波数帯Ｂ５，Ｂ７の測定を行う毎に、１個の単位ユニットで、その他の周波数帯Ｆｅｄ１～Ｆｅｄ５のいずれかの測定を順番に実行する。つまり、路上機が提供するアプリケーションがＥＴＣアプリケーションである場合、車載器４０は、３単位ユニット以内に使用周波数帯が特定され、ＥＴＣアプリケーションを開始できるようにされている。

【０１４３】また、図２６（ｂ）は、路上機情報からＥＴＣアプリケーション以外のアプリケーションが提供されることのない区域にいると判定された場合に設定される切替パタンを示したものであり、ユニット数Ｕｍａｘは２である。具体的には、周波数帯Ｆｅｄ１～Ｆｅｄ５を測定する必要がないため、ＥＴＣ周波数帯Ｂ５，Ｂ７の測定のみを繰り返し実行することになる。

【０１４４】そして、ユニット数をカウントするためのカウンタのカウント値ｉを１に初期化し（Ｓ１１３０）、車速センサからの信号を処理するＥＣＵ等から、車両の走行速度を表す速度情報を取得する（Ｓ１１４０）。この速度情報に従って、単位ユニットを、図２６（ｃ）に示すように、走行速度が早いほど単位ユニット時間が短くなるように設定し（Ｓ１１５０）、この単位ユニット時間を測定するためのタイマーをスタートさせる（Ｓ１１６０）。

【０１４５】次にカウント値ｉに基づいて、切替パタン中のｉ番目の単位ユニットに対応する周波数帯の電界強度を測定し（Ｓ１１７０）、その電界強度が予め設定された下限値以上であるか否かを判断する（Ｓ１１８０）。そして、電界強度が下限値より小さければ、先のＳ１１６０にてスタートさせたタイマーが、タイムアウトしたか否かを判断し（Ｓ１１９０）、タイムアウトしていなければＳ１１７０に戻って、電界強度の測定を繰り返す。一方、タイマーがタイムアウトしている場合には、先のＳ１１１０にて取得した位置情報の地点から所定距離以上移動したか否かを判断し（Ｓ１２００）、所定距離以上移動していれば、Ｓ１１１０に戻って位置情報の取得と切替パタンの再設定とを行って、電界強度の測定を繰り返す。

【０１４６】また、所定距離以上移動していない場合には、カウンタのカウント値ｉをインクリメントし（Ｓ１２１０）、カウント値ｉが切替パタンのユニット数Ｕｍａｘより大きいか否かを判断し（Ｓ１２２０）、ユニット数Ｕｍａｘより大きければカウンタのカウント値ｉを１に初期化（Ｓ１２３０）した後にＳ１１４０に戻り、一方、ユニット数Ｕｍａｘ以下であれまそのまま何もしないでＳ１１４０に戻る。

【０１４７】先のＳ１１８０にて、測定により得られた電界強度が予め設定された下限値以上であれば、ｉ番目のユニットに対応する周波数帯の中心周波数を、検出周

波数として記憶し（Ｓ１２４０）、本処理を終了する。ところで、単位ユニット時間は、次のようにして設定される。即ち、車両の走行速度をＶ〔ｍ／ｓ〕、路上機の通信エリアの大きさをｓ〔ｍ〕とすると、車両が通信エリアを通過する所要時間ｔｐは、（１）式にて表わすことができる。

【０１４８】

ｔｐ＝ｓ／Ｖ〔ｓ〕　（１）

通常、この所要時間ｔｐ内にリトライを含めてアプリケーションの提供に必要な一連の通信が３回程度可能なように全データ量が設定される。例えば、ｓ＝５〔ｍ〕の場合、Ｖ＝１０〔ｍ／ｓ〕（＝３６〔ｋｍ／ｈ〕）とすると、ｔｐ＝５００〔ｍｓ〕であり、アプリケーション提供のために使用可能な時間は、約１７０〔ｍｓ〕（＝ｔｐ／３）となり、またＶ＝３０〔ｍ／ｓ〕（＝１０８〔ｋｍ／ｈ〕）とすると、ｔｐ＝１６７〔ｍｓ〕であり、アプリケーション提供のために使用可能な時間は約５０〔ｍｓ〕となる。

【０１４９】そして、切替パタンの１周期は上述したように最大１５個の単位ユニットからなり、この切替パタンの１周期がアプリケーション提供のために使用可能な時間５０～１７０〔ｍｓ〕に対して十分に小さくなるように、単位ユニット時間を決定する。例えば、切替パタンの１周期を１〔ｍｓ〕とすれば、単位ユニット時間は１／１５〔ｍｓ〕程度となる。

【０１５０】なお、ＥＴＣ以外のアプリケーションでは、停車中或いは極低速での通信が前提となっているため、アプリケーション提供のために使用可能な時間は秒単位で確保されるため、上述のようにＥＴＣアプリケーションを中心に切替パタンや単位ユニット時間を設定したとしても、十分な処理時間を確保することができる。

【０１５１】本実施形態において、Ｓ１１７０が電界強度測定手段、Ｓ１２１０～Ｓ１２３０が周波数切替手段、Ｓ１１１０が位置取得手段、Ｓ１１４０が速度取得手段、メモリ４６が記憶手段、Ｓ１１２０が切替パタン設定手段に相当する。以上説明したように、本実施形態の車載器では、予め設定された周波数帯Ｂ１～Ｂ７を切替パタンに従って順次サーチすることにより、路上機がアプリケーションの提供に使用している周波数帯を特定するようにされており、しかも、切替パタンはＥＴＣ周波数帯の出現頻度が高くなるように設定されている。

【０１５２】従って、本実施形態の車載器によれば、多くの周波数帯を使用して多様なアプリケーションに対処できるだけでなく、路上機からＥＴＣアプリケーションが提供されている時には、これを速やかに検知して速やかにＥＴＣアプリケーションを開始することが可能となる。その結果、車両が比較的高速で走行している時に実行され、処理に許容される時間が短いＥＴＣアプリケーションであっても、通信リトライ用の余裕時間、ひいては通信の信頼性を十分に確保することができる。

【０１５３】また、本実施形態の車載器では、車両の位置を表す位置情報に基づいて、区域を特定し、その特定された区域内の路上機が使用する周波数帯のみを用いて切替パタンを設定すると共に、車両の走行速度を表す速度情報に基づいて、各周波数帯を測定する１回当たりの測定時間である単位ユニット時間を、走行速度が早いほど短くなるように変化させている。

【０１５４】従って、本実施形態の車載器によれば、路上機がアプリケーションの提供に使用している周波数帯を無駄なく特定することができ、また、高速な走行時であっても、アプリケーションの実行のための処理時間を十分に確保することができる。

【０１５５】なお、本実施形態において、電界強度検出部１２は、設定された周波数帯Ｂ１～Ｂ７の中からいずれか一つの周波数帯の電界強度を測定するように構成されているが、複数の周波数帯の電界強度を同時に測定できるように構成してもよい。また、本実施形態では、位置情報に応じて切替パタンを変更したり、速度情報に応じて単位ユニット時間を変更するようにされているが、切替パタンや単位ユニット時間は、いずれか一方或いは両方が固定であってもよい。

【０１５６】更に、本実施形態では、切替パタンのなかでの出現頻度が多くなる特定アプリケーションとしてＥＴＣアプリケーションを用いているが、これ以外に、走行中の車両から車両情報を読み取る電子ナンバープレートに関するアプリケーションを特定アプリケーションとして用いてもよい。

【０１５７】なお、路上機が提供するＥＴＣ以外のアプリケーションとして、例えばデパートの駐車場に路上機を設置し、そのデパートのＷＥＢページを車両にダウンロードして、デパートのセール情報や催し物情報などを顧客に知らせたり、更に、その情報をＰＤＡや携帯電話のような電子機器に記憶させることにより売場でのサービス提供に利用してもよい。

【０１５８】また、コンビニエンスストアの駐車場に路上機を設置し、車両から降りることなく種々の金銭支払いをできるようにしたり、音楽配信やゲーム配信を車両内で受けることができるようにしてもよい。また、単純な伝言板のような使い方をしてもよい。

【０１５９】また、駐車場出口に路上機を設置し、出口付近を走行する車両に駐車場からの車両の退出を知らせる等してもよい。また、道路付近に設置された路上機により、様々な場所にてリアルタイムな交通情報や、現在位置を知るための情報（例えば交差点名など）を提供するようにしてもよい。

【０１６０】また更に、バスやタクシー或いは運送トラック等の運行管理システムに適用し、各車両の運行状況や配車状況の把握や、各車両への事故情報等の伝達などを、各車両に搭載された車載器と路上機との通信により行うように構成してもよい。

【図面の簡単な説明】

【図１】　第１実施形態の路車間通信システムにおける車載器の概略構成を表すブロック図である。

【図２】　データ処理部が実行するメイン処理の内容を表すフローチャートである。

【図３】　アクティブ通信部の動作内容を表すフローチャートである。

【図４】　パッシブ通信部の動作内容を表すフローチャートである。

【図５】　変形例のメイン処理の内容を表すフローチャートである。

【図６】　第２実施形態の路車間通信システムにおける路上機の概略構成を表すブロック図である。

【図７】　アクティブ通信部の動作内容を表すフローチャートである。

【図８】　ＭＤＳ処理の詳細な内容を表すフローチャートである。

【図９】　パッシブ通信部の動作内容を表すフローチャートである。

【図１０】　料金所の構成例、及びタイミング制御部での制御方法を表す説明図である。

【図１１】　料金所の構成例、及びタイミング制御部での制御方法を表す説明図である。

【図１２】　料金所の構成例、及びタイミング制御部での制御方法を表す説明図である。

【図１３】　タイミング制御部での制御方法を表す説明図である。

【図１４】　データ処理部が実行するＭＤＳ割当処理の内容を表すフローチャートである。

【図１５】　ＭＤＳ割当処理に基づく制御状態を表す説明図である。

【図１６】　第３実施形態の路車間通信システムにおける路上機の概略構成を表すブロック図である。

＊【図１７】　路車間通信システムにて用いられる通信フレームの構成、アンテナ切替部の動作を表す説明図である。

【図１８】　共用通信部の動作内容を表すフローチャートである。

【図１９】　ＭＤＳ処理の詳細な内容を表すフローチャートである。

【図２０】　データ処理部が実行するＭＤＳ割当処理の内容を表すフローチャートである。

【図２１】　ＤＳＲＣにて通信に使用される周波数帯の分布を表す説明図である。

【図２２】　従来のパッシブ方式及びアクティブ方式における通信フレームの構成を表す説明図である。

【図２３】　第４実施形態の路車間通信システムにおける車載器の概略構成を表すブロック図である。

【図２４】　データ処理部が実行するメイン処理の内容を表すフローチャートである。

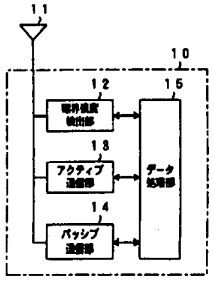
【図２５】　メイン処理の中で実行される周波数スキャンの詳細を表すフローチャートである。

【図２６】　電界強度測定時の測定周波数帯の切替パタンを表す説明図である。

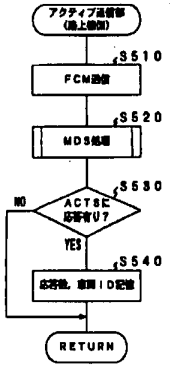
【符号の説明】

１０，４０…車載器、１１，４１…アンテナ、１２，４２…電界強度検出部、１３，４３…アクティブ通信部、１４，４４…パッシブ通信部、１５，４５…データ処理部、４６…メモリ、２０，３０…路上機、２０ａ…共用路上機、２０ｂ…アクティブ専用路上機、２０ｃ…パッシブ専用路上機、２１，２３，３１ａ，３１ｂ，３２…アンテナ、２２…アクティブ通信部、２４…パッシブ通信部、２５…タイミング制御部、２６，３６…データ処理部、３３…方向性結合器、３４…アンテナ切替部、３５…共用通信部、Ｌ１，Ｌ２，Ｌ３…車線、Ｍ１，Ｍ２，Ｍ３…料金所。

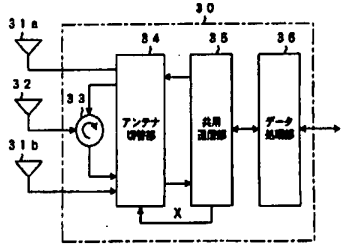
【図１】



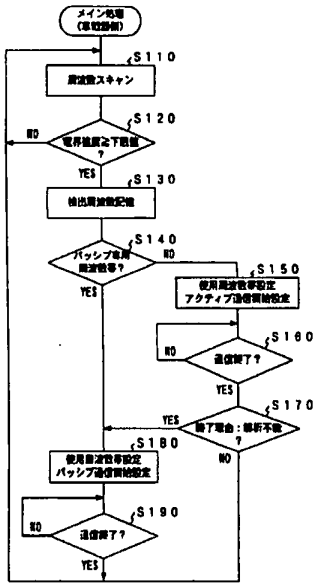
【図７】



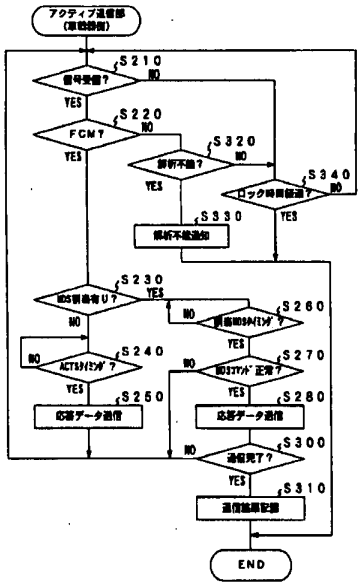
【図１６】



【図2】



【図3】



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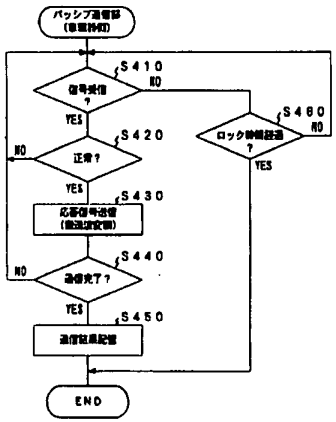

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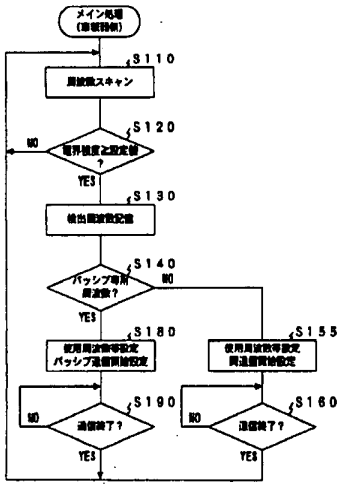

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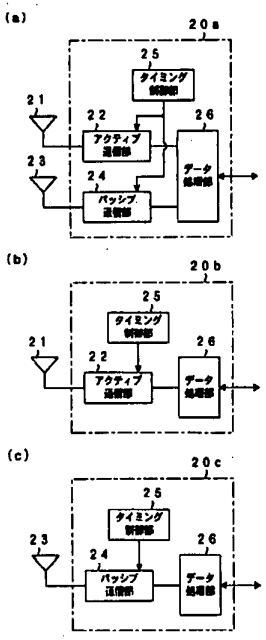

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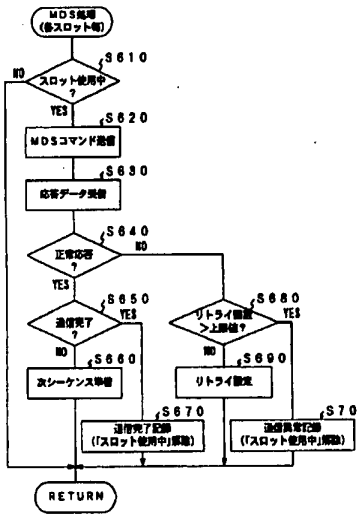

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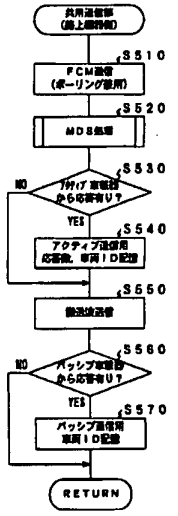

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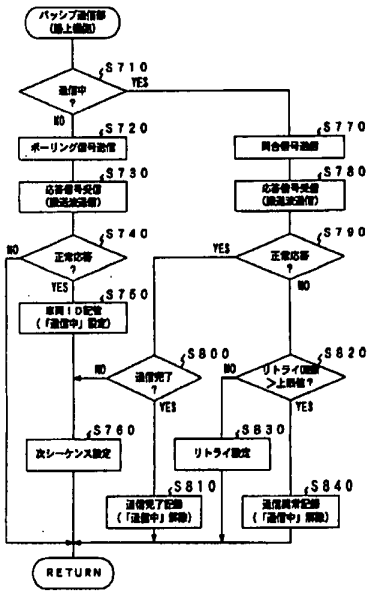

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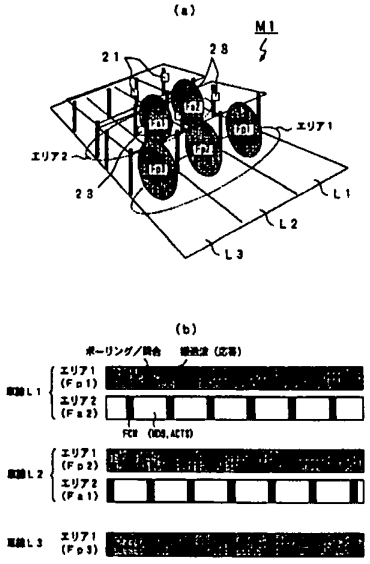

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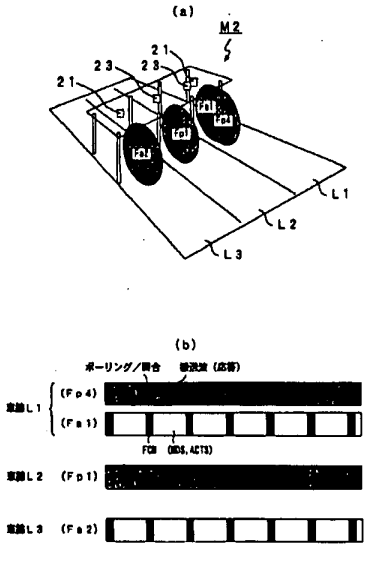

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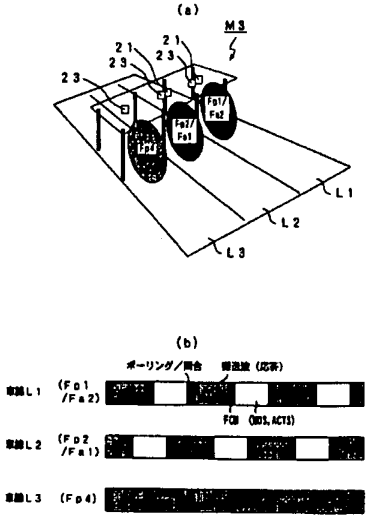

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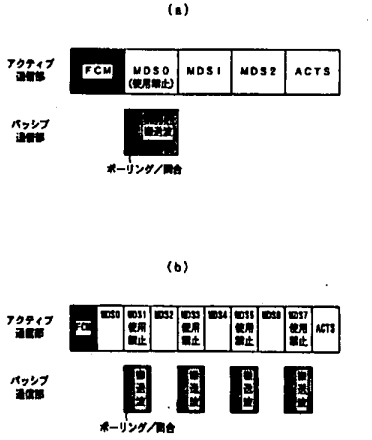

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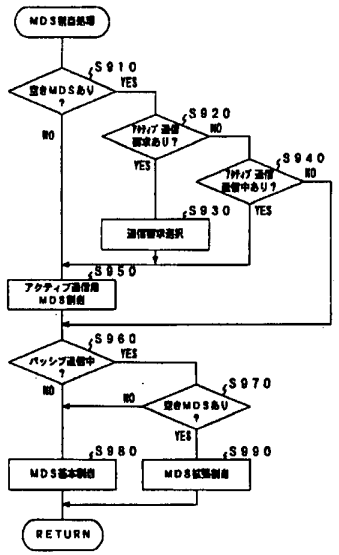

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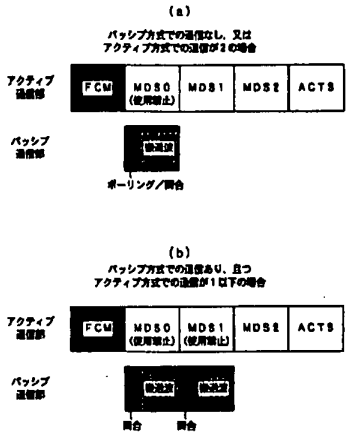

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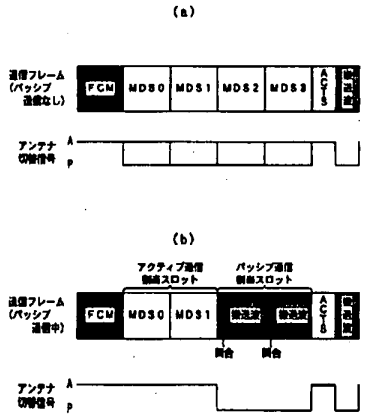

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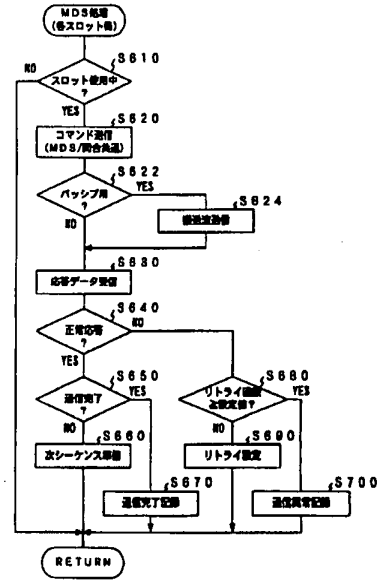

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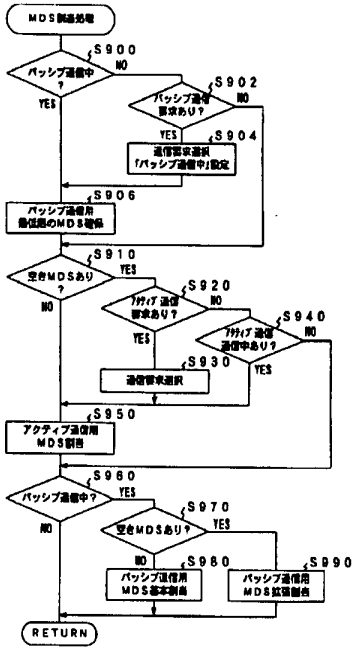

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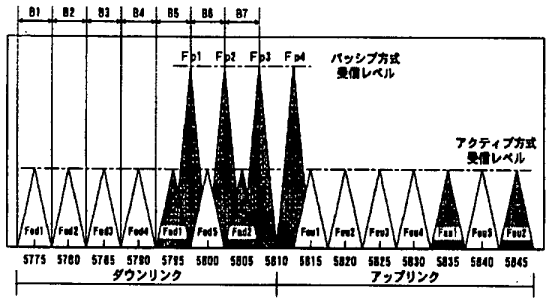

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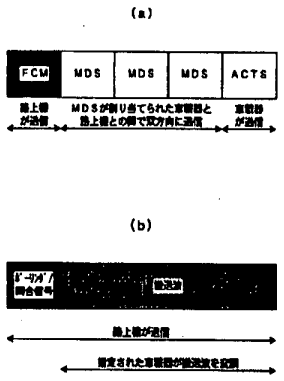

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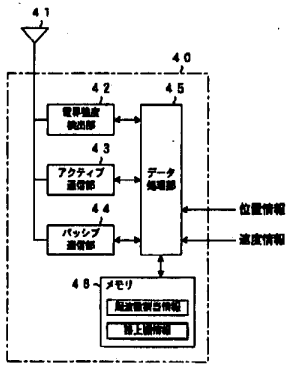

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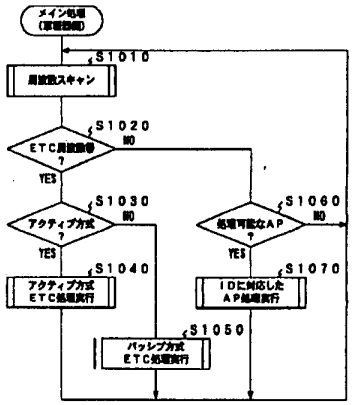

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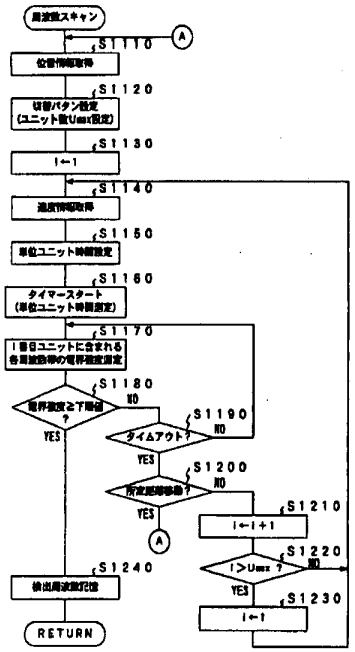

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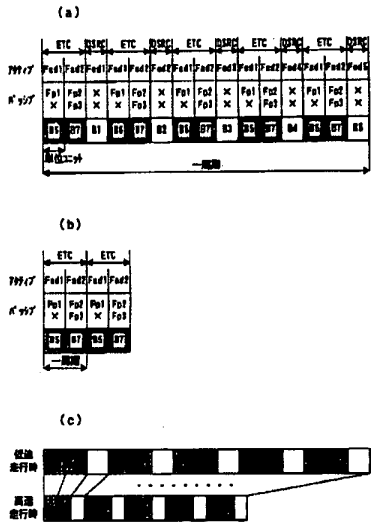

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